

“TECHNOGEOPOLOGISTICS”: SUPPLY NETWORKS AND MILITARY
POWER IN THE INDUSTRIAL AGE

BY

JOBIE S. TURNER, Lt Col, USAF

A THESIS PRESENTED TO THE FACULTY OF
THE SCHOOL OF ADVANCED AIR AND SPACE STUDIES
FOR COMPLETION OF GRADUATION REQUIREMENTS

SCHOOL OF ADVANCED AIR AND SPACE STUDIES

AIR UNIVERSITY

MAXWELL AIR FORCE BASE, ALABAMA

JUNE 2012

APPROVAL

The undersigned certify that this thesis meets master's-level standards of research, argumentation, and expression.

Dr. STEPHEN D. CHIABOTTI

Dr. JAMES W. FORSYTH, JR.



DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.



ABOUT THE AUTHOR

Lieutenant Colonel Jobie Turner was a 1996 graduate of the United States Air Force Academy. He has a Master's Degree in History from the University of Georgia and a Master's Degree in Air Transportation Management from the Air Force Institute of Technology. He is a C-130 pilot with various overseas and stateside assignments culminating with his last assignment as a staff officer at United States Transportation Command.



ACKNOWLEDGMENTS

The leadership at USTRANSCOM allowed Majors and Lieutenant Colonels, to think big and try innovative approaches. Such freedom of action and creativity provided an excellent learning environment. I would like to thank Gen (ret.) McNabb, VADM Harnitchek, Maj Gen Johnson, Mr. David Blomberg, and Lt Col Jeff Brown for allowing me to learn about logistics, setting me up to attend SAASS, and for constantly reminding us that logistics was about the warfighter, and not about the logisticians. I hope that message comes through in this paper.

The SAASS faculty is a rare organization within the academic community. Everything they do is focused on the students. The time, effort, and professionalism they put into their work here is beyond reproach. Thanks to Dr. Dolman, Dr. Hughes, Dr. Wright, Dr. Roland, Dr. Sheldon, Col Smith, Col Yeisley, Col Kometer, and Col Buono for the excellent classroom instruction.

I would like to thank Dr. Muller for answering my frequent and annoying questions about the German *Luftwaffe*, his insight, graciousness, and sources were much appreciated. I also want to thank Col Schultz for letting me finish Air War College and providing valuable insight as a mentor throughout this year. I would also like to thank Dr. Forsyth for starting my SAASS year off right in SAASS course 601, allowing me to push the bounds of creativity in my first paper submission, and his great humor, support, insight, and edits to this thesis. I especially want to thank Dr. Chiabotti, who over nineteen years has provided mentorship, friendship, and intellectual challenge. It is a rare multi-paradigmatic translator who can teach you how to fly, help you cut through the medical bureaucracy of the Air Force, and help chart a course for two theses. Despite his exhortations to call him Steve, he will always be "Col Chiabotti" to me. The work on this paper was the most challenging and fun I have ever had in any intellectual endeavor. He helped make this thesis a better product through a keen eye for my poor grammar, disjointed logic, and tendency to use nouns as adjectives.

Most importantly, I want to express my sincere appreciation to my wife, daughter, and son. My wife's love, patience, and understanding as I struggled to get this paper complete were unrivaled. Thanks to her for making this a fun year! Thanks to my daughter for being willing to read James and the Giant Peach or one of her other books, while I read the SAASS book of the day at five in the morning. Thanks to my son for encouraging me to play monster tag and briefly delaying this thesis. I will always treasure that time together. You all make the best of every situation and make everything in my life brighter.

ABSTRACT

This thesis examines the impact of technology on logistics and geopolitics during the two major industrial wars of the twentieth century. Through the theoretical lenses of Mahan, Mackinder, Douhet, and Mitchell, the author assesses the validity of sea, land, and air lines of communication in relation to each other and to combat power. While air lines of communication can quickly deliver troops and supplies to the battlefield, they lack the robust capability of sea and land communications. However, airpower provides the range and flexibility to attack sea and ground lines of communication, making it the great arbiter between the two mediums.

Ultimately, lines of communication are very sensitive to technological change. By the end of World War II, technology gave the belligerents the ability to attack anywhere on the globe. This in turn reshaped geopolitical concerns into a contest between logistics, combat power, and industrial supply chains. While each of the single-medium theories has explanatory power for industrial warfare, they each lack sufficiency on their own to guarantee victory. Those nations, personified in the United States and the Soviet Union, which best conveyed their industrial resources, logistics, and combat power in a vertical supply chain, while also harnessing their alliances through a strategic horizontal logistics network, won the wars.

Air University—Maxwell AFB, AL

CONTENTS

Chapter

APPROVAL	i
DISCLAIMER	ii
ABOUT THE AUTHOR.....	iii
ACKNOWLEDGMENTS	iv
ABSTRACT	v
INTRODUCTION	1
1 ALFRED THAYER MAHAN AND THE SEA	11
2 LOCOMOTION FOR THE ADMIRAL'S OCEAN: HALFORD MACKINDER, LAND COMMUNICATIONS, AND RAIL POWER	27
3 WORLD WAR I: RAIL, WAVE, AND THE SPARK OF WAR.....	464
5 WORLD WAR II: CONSUMPTION, SUPPLY, AND ARBITRATION	104
CONCLUSIONS.....	165
BIBLIOGRAPHY	171

Illustrations

Table

1 1914 RERESSENTATIVE TECHNOLOGIES	49
2 1939 RERESSENTATIVE TECHNOLOGIES	108

Figures

1 MACKINDER'S MAP: RUSSIA AS HEARTLAND OR GEOGRAPHICAL PIVOT OF HISTORY ALFRED THAYER MAHAN AND THE SEA	3
2 THE BRITISH EMPIRE AND THE ATLANTIC OCEAN	16

3	MAHAN'S MEDITERRANEAN MAP OF THE PUNIC WARS.....	204	CARTO
5	MACKINDER'S MAP 1904	32	
6	THE SCHLIEFFEN PLAN	52	
7	GORLICE-TARNOW BREAKTHROUGH	80	
8	THE ARABIAN CAMPAIGN	89	



Introduction

I have spoken as a geographer. The actual balance of political power at any given time is, of course, the product, on the one hand, of geographical conditions, both economic and strategic, and on the other hand of the relative number, virility, equipment and organization of the competing peoples.

Halford J. Mackinder, 1904

As the industrial age settled into full maturity at the turn of the twentieth century, the world enjoyed the fruits of a relatively peaceful epoch. After the American Civil War and the Franco-Prussian War, there would be no major conflict between great powers—excepting the Russo-Japanese War in 1905—until the First World War. Underneath the calm exterior of a more prosperous and modern world, the industrial age was reinventing the technology of warfare. This technology enhanced the speed, range, and the killing power of belligerents. In turn, technological improvements demanded exponential increases in logistics, from energy supplies and equipment to spare parts and food, which required a national industrial base linked through lines of communication (LOCs) to the battlefield in ever more complex ways. Thus, logistics exhibit sensitivity to technological change.

Logistics also have the power to transform culture and geopolitics. Lynn White, for example, documents the effects of equine horticulture on the urbanization of France in the high Middle Ages.¹ Hence, to speak of “geopolistics,” while perhaps both ambitious and pretentious, is not enough. This study, at its core, concerns itself with “technogeopolistics,” or how changes in transportation technologies ultimately affect geopolitical dynamics through the aegis of military

¹ Lynn Townsend White, *Medieval Technology and Social Change* (Oxford,: Clarendon Press, 1962), 28-30. In this classic text, White details how the stirrup revolutionized warfare and made the horse, and the large amount of land needed to feed the animal, the basis for feudalism.

force. The First and Second World Wars will stand as case studies for the industrial age.

The variety and sheer mass of technologies produced by industrialized societies and used during the two conflagrations defies comprehension. From the submarine and the truck, to the sea mine and the atomic weapon, modern technologies gave belligerents the ability range anywhere on the planet while also destroying any chosen target. As part of this technological panoply, the internal combustion engine represented the pinnacle of industrial-age transportation technology. The engine not only affected sea and land warfare, through such vehicles as the aircraft carrier and the tank, but also created a third domain of operation where the airplane flourished.

Before the airplane, the sea and land domains could not interact much beyond the water's edge. Thus, supplies flowed from the sea to the land and the battlefield or from a land base of supply over roads to the battlefield. In either case, the ability to project combat power onto an adversary's internal lines of communication was limited, other than instances of guerrilla warfare, such as French partisans during the Franco-Prussian War. The airplane, with its ubiquitous presence, altered the relationship between sea and land logistics. How the airplane changed the transportation of goods and services during the two world wars, whether as a combat technology or as a transportation vehicle in its own right, is an important factor in illuminating the relationship between technology, logistics, and geopolitics.

Beyond individual technological innovations, industrial economies demanded a new relationship between the state and the battlefield. Much as raw-material extraction, manufacturing, and transportation to market existed in peacetime, wartime demanded the same system serve the ultimate consumer—the battlefield. As the economies of the industrial age grew and strengthened between the wars, networking both internal and external supply chains with battlefield logistics

became increasingly important. In turn, a geopolitical analysis of how these logistics networks affected alliances that were not only transcontinental, but also global in nature, is needed. For example, did the egalitarian politics of the Allies translate into logistics networks in any way? On the opposite side, were the isolation of the Central Powers in the First World War and the unequal racially superior alliances of the Axis detrimental to their logistics systems?

The Theoretical Lens

The two theorists who best understood and expressed the impact of commercial and military transportation on a nation's power were Alfred Thayer Mahan and Halford J. Mackinder. While the former espoused the power of sea transportation, the latter believed that the railroad had given land power an edge. Mackinder articulated his view in graphic form in his famous world map with Russia—"The Heartland"—at the center of the world (See Figure 1).

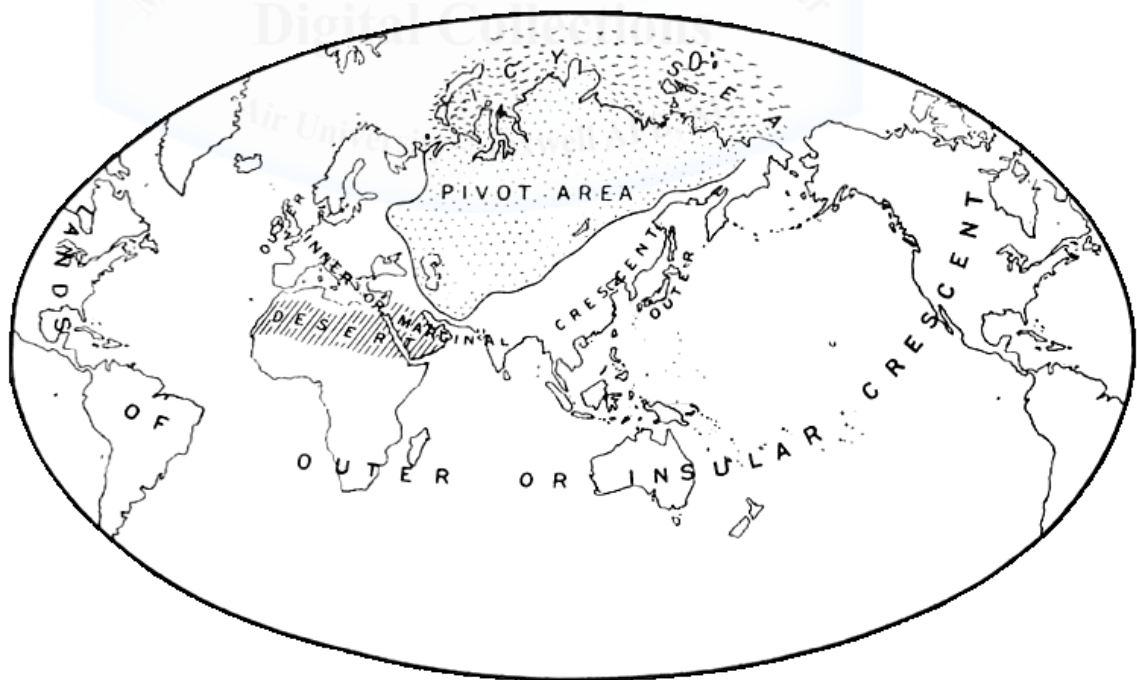


Figure 1: Mackinder's Map: Russia as Heartland or Geographical Pivot of History

Source: Halford J. Mackinder, "The Geographical Pivot Point of History."

These thinkers offer important templates with which to analyze the role of transportation networks in conveying national power during the industrial age. Mahan's sea power relies on the battle fleet and possession of key geographic points to protect the commons for economic and military benefit. Mackinder's ideas of railroads and their transformation of international power relationships on the land, represent a stark contrast to Mahan. The crucible of the First World War will serve as a lens for sea versus land LOCs. With the addition of the air LOC under the inter-war airpower thinkers Giulio Douhet and Billy Mitchell, the Second World War will be a testing ground for all three domains. The interaction among sea, land, and air LOCs with both the industrial capacity of the nation on one end and the killing power in war on the other, will determine whether the single-LOC theories hold up to industrial warfare or whether they fail. In addition, an examination of each theorist through the lenses of two industrial wars will foster a better appreciation of the sensitivity of logistics to technological change. This technological discussion will help illuminate the positives and negatives of each theorist's perspective on logistics and combat power.

Lines of Communication

Delivering militaries to the battlefield, sustaining them, and bringing them home are critical components of warfare. The term Line of Communications (LOC) embodies this idea. According to the United States Department of Defense, an LOC is, "A route, either land, water, and/or air, that connects an operating military force with a base of operations and along which supplies and military forces move."² LOC is not a new concept, but rather represents the logistical underpinnings of an ancient way of warfare—moving into foreign territory and establishing control. Before the Athenian Commander Nicias led the ill-fated

² United States Department of Defense, *Department of Defense Dictionary of Military and Associated Terms*, 2010, 211.

expedition to Syracuse in 415 B.C., he declared, "...we must also provide ourselves with everything else as far as we can, so as not to be dependent upon others."³ In the same vein, United Transportation Command (USTRANSCOM), commander General Duncan McNabb stated recently, "...our logistical forces must be equally capable of meeting war-fighter needs in uncontested, semi-contested, and contested domains; favorable and unfavorable terrain; all types of weather; and places with limited or no infrastructure."⁴ Thus, when viewed through a broad historical lens, LOCs both support military operations and become a crucial strategic concern in their own right.

Military communications are also embedded into the global transportation route structure with the commercial traffic that transits the same lanes. This was the case as much for the Athenians during the Peloponnesian wars as it is for the United States today.⁵ The British Empire with its naval supremacy and global mercantilist empire from the late 17th to the early 20th century represented the best example of the blending of military power with corresponding economic capability. In fact, according to Paul Kennedy in *The Rise and Fall of British Naval Mastery*, Britain's naval success and economic domination had direct correlation; thus, any study of British power during the period must examine both.⁶ The U.S. Navy's mission "to maintain, train and equip combat-ready naval forces capable of winning wars, deterring

³ Thucydides, Robert B. Strassler, and Richard Crawley, *The Landmark Thucydides : A Comprehensive Guide to the Peloponnesian War* (New York: Free Press, 1996), 374-375.

⁴ Duncan McNabb, "We Measure Success through the Eyes of the War Fighter," *Air and Space Power Journal* XXV, no. 4 (2011): 8.

⁵ Thucydides and others, *The Landmark Thucydides*, 372-373. The attempted Athenian conquest of Sicily was both a manifestation of the city-states naval power and the implied economic routes that Athens would control by subjugating the island.

⁶ Paul M. Kennedy, *The Rise and Fall of British Naval Mastery*, (Atlantic Highlands, N.J.: Macmillan, 1983), xxvii.

aggression and *maintaining freedom of the seas*” illustrates how important commercial shipping is to national interests today.⁷

Mahan and Mackinder

Until the 20th century, LOCs transited two mediums—land and sea. Alfred T. Mahan, who espoused the latter, and Halford Mackinder, who evangelized the former, were their two most articulate advocates. Mahan placed sea LOCs in both military and commercial contexts. Mahan attributed the success of the British Empire to the nation’s command of the sea. He believed command of the sea was necessary to both secure trade routes for commerce and economic growth, and deliver armies to their destination.⁸ While Mahan considered sea power, and specifically the maintenance of sea lanes critical for national economic and military power projection, he did so within a specific context. The title of *The Influence of Sea Power Upon History 1660-1783* calls attention to Mahan’s emphasis on the age of sail; yet his conclusions belie the influence of technology on power projection and geopolitics—to a fault.

Ironically, Mahan published *The Influence of Sea Power on History* in the late 19th century, at precisely the moment when railroads provided nations possessing the right geographic position and physical conformation considerable advantage in moving goods and services to their frontiers and beyond. Mackinder seized upon this technological development, while Mahan seems to have ignored it.

Despite his technological shortcomings, Mahan remains relevant on the importance of sea lines of communication to national economic and military success. In 2009, over 90% of supplies moved by the U.S

⁷ The United States Navy, "Mission of the United States Navy" <http://www.navy.mil/navydata/organization/org-top.asp> (accessed 13 January 2012).

⁸ A.T. Mahan, *The Influence of Sea Power Upon History: 1660-1873*, (Mineola: Dover Publishing, 1890), 25-26.

military transited by sea.⁹ On the commercial side, sea modes of transportation carried 99.7% of all transoceanic foreign trade, while airlift accounted for just 0.3%, and rail, quite naturally, none at all.¹⁰ In transoceanic movement of goods and services, Mahan still holds sway. Although he wrote during the post-industrial revolution era, Mahan's analysis rings true from the Athenians, to the Romans, to the British in the 19th century, and to the two industrial wars of the twentieth century. The nation that can command the sea heavily influences the global economy and the military affairs of the world.

Although writing only a decade after Mahan, Halford Mackinder understood that the railroad had introduced a new element to global transportation. In 1904, he wrote a journal article entitled *The Geographical Pivot of History*. In doing so, Mackinder created the modern study of geopolitics, which Merriam-Webster defines as “a study of the influence of such factors as geography, economics, and demography on the politics and especially the foreign policy of a state.”¹¹ In this classic work, he pitted the newly developed railroad against sea transportation in comparing their power to influence political, military, and economic activities on the world stage.¹² Mackinder concluded that the railroad had eclipsed sea movement, and the nations best served by the former, Russia and East Europe, were at the height of potential for world hegemonic power.

⁹ United States Transportation Command, *Annual Command Report*, Scott Air Force Base: 2009, 3.

¹⁰ United States Department of Transportation, *Freight Transportation: Global Highlights 2010*, Washington, DC:2010. 38. This figure does not compare the land component of international trade and commerce. In addition the value of goods moved by air greatly exceeds the weight. For example, in internal US cargo movements air only carried 0.4% of the total weight, but 25% of the total value of cargo delivered.

¹¹ Merriam-Webster Inc., *Merriam-Webster's Collegiate Dictionary*, 11th ed. (Springfield, Mass.: Merriam-Webster, Inc., 2003), 524. The dictionary lists its origin as 1904, the year Mackinder first produced his Geographical Pivot article.

¹² Halford J. Mackinder, "The Geographical Pivot of History (Reprint of 1904 Article)," *The Geographical Journal* 170, no. 4 (2004): 423.

Given the importance of the railroad and land powers, Mackinder redrew the world map. His map (Figure 1) listed Russia and Eastern Europe as the Heartland and the pivot point of history. In Mackinder's own words, "A generation ago steam... increased the mobility of sea-power relatively to land-power...transcontinental railways are now transmuting... land-power and nowhere can they have such effect as in the closed heart-land of Euro-Asia..."¹³

Like Mahan, Mackinder's ideas still permeate world affairs. His astute understanding of the impact of technology on transportation and state power define much of US commercial and military success in the post- World War II era. As Colin Gray notes, Americans may have had poor leadership in war and average weapons quality, but they managed victory through superior logistics.¹⁴

World War I

Mackinder's concept of global power and logistics met Mahan's concept of sea power and logistics during World War I. A great land power in Germany, bolstered by its war-tested railroads, squared off against the Allies, supplied from the British-ruled seas.¹⁵ The interplay between sea and land logistics and combat power on both the Western and Eastern Fronts determined which theory held sway. During this same conflict the internal combustion engine, in the form of the tank, the truck, and the airplane, would begin its entry onto the stage paving the way for a much larger, even decisive, role in the Second World War.

Critical thought about technology, logistics, and geopolitics finds a template in Mahan and Mackinder useful for evaluating the tools of war and transportation birthed by the industrial age and its aftermath. For example, did the submarine and sea mine allow the Germans to become a sea power on par with the historic masters of the sea, the British?

¹³ Mackinder, "The Geographical Pivot," 434.

¹⁴ Colin Gray, *Explorations in Strategy*, (Westport: Praeger, 1996), 88.

¹⁵ Richard Holmes and others, *The Oxford Companion to Military History* (Oxford ; New York: Oxford University Press, 2001), 552-553.

Was the uniting of the majority of the Heartland a panacea for the Germans as Mackinder promised, or did the Allied logistics network, eventually bolstered the US, make more of a difference?

Douhet and Mitchell

Douhet remains airpower's foremost theorist. Through command of the air, Douhet advocated the striking of enemy populations directly, including the use of incendiary and chemical weapons in order to attack a nation's morale.¹⁶ Far from support for ground or sea LOCs, Douhet advocated an entirely separate and war-winning LOC stretching from one nation's runways to the enemy nation's population.

As opposed to Douhet, Mitchell imagined a world unbound by classic notions for sea or land LOCs "no condition of this kind confronts aircraft as the air is a common medium all over the world."¹⁷ Given its ability to touch all areas of the globe, Mitchell saw the airplane as a key component to a modern economy in peacetime. Conversely, it was through the destruction of the same-said modern economy that Mitchell saw the future mission for the airplane.¹⁸ Mitchell also placed the aircraft clearly in opposition to sea power—most famously demonstrating the ability of aircraft to sink captured German battleships in the 1920s.¹⁹

World War II

As Mackinder noted in his analysis, technology can change international commerce and power-structure alignment.²⁰ Nowhere was this truer than in the airplane's impact on World War II communications. The improvement of the airplane in the post-World

¹⁶ Giulio Douhet, Joseph P. Harahan, and Richard H. Kohn, *The Command of the Air*, Fire Ant Books (Tuscaloosa, AL: University of Alabama Press, 2009), 58.

¹⁷ William Mitchell, *Winged Defense; the Development and Possibilities of Modern Air Power - Economic and Military*, 2009 ed. (Tuscaloosa: The University of Alabama Press, Fire Ant Books, 1925), 78.

¹⁸ Mitchell, *Winged Defense*, 126-127.

¹⁹ Mitchell, *Winged Defense*, 42-43.

²⁰ Halford J. Mackinder, *Democratic Ideals and Reality: A Study in the Politics of Reconstruction* (New York: Henry Holt and Company, 1919), 14.

War I period and its subsequent use as a transportation asset, together with improved internal combustion engines in trucks and tanks, restored movement to the battlefield despite the relatively constricted geography of Western Europe. During World War II, airpower granted armies and navies more freedom of maneuver and gave the belligerents the ability to attack each other's populations directly.

So how indeed did the addition of the airplane, along with the improved technologies of the truck and the tank alter the classic problem of logistics: moving manufactured goods and people to the front and sustaining them toward victory? What became of the age-old security of internal lines of communication? How did airpower affect the balance between sea and land-oriented polities that emerged in the First World War? How did the ideology of alliances affect their ability to construct coherent logistic networks? Was Mackinder's conception of the Eurasian Heartland as the pivot of history correct? Why did Nazi Germany's dominance of this area for nearly four years not translate to victory in a global war? Answers to these questions may prove constructive as we contemplate the roles of technology and logistics in geopolitics for the information age.

Chapter 1

Alfred Thayer Mahan and the Sea

The first true geostrategic (global-scale) advocate of sea power was...Alfred Thayer Mahan. Mahan believed maritime power was the key to great power status, and that this power was to some extent geodetermined. His monumental maritime studies...were enormously popular, and his ideas influenced US, British, German, and Japanese foreign policy.

Everett Dolman

A.T. Mahan was a United States Naval Officer during the turn of the 19th Century. He greatly wished for the United States to join the ranks of world powers using sea power. In order to make his case for the benefits of sea power to the United States, his theory places great emphasis on the economic benefits gained from global sea commerce. In order to reap the advantages of commerce, Mahan requires a robust naval force and the necessary geographic positions to establish, maintain, and defend trade routes. Thus, he views sea Lines of Communication (LOC) as the critical flow of goods and military power that the navy must keep open.

For Mahan, the naval force required to maintain the sea LOCs is a large ship-of-the-line fleet. The big battle fleet is so important to Mahan's analysis, that he considers it a timeless element. Therefore, he views any future technological advancement as only a threat to naval tactics and not to greater sea power strategy.¹

Despite his ahistorical view of technology, Mahan's theory has great success in three areas. First, Mahan's theory describes the

¹ A.T. Mahan, *The Influence of Sea Power Upon History: 1660-1873* (Mineola: Dover Publishing, 1890), 22. Mahan quotes Jomini: "as to whether recent improvements in firearms would cause any great modification in the way of making war...they would probably have an influence upon the details of tactics, but that in great strategic operations and the grand combinations of battles, victory would, now as ever, result from the application of the principles which had led to the success of great generals in all ages."

underlying elements of today's global economy. Currently, those nations with the largest ocean-going commerce and largest navies (i.e. the US and China), have the most economic power. Those nations without natural access to the sea, or the ability to have significant sea commerce, remain marginalized. Second, Mahan's theory explains the successes of the Allied causes in World War I and World War II at a macro level. The Allies eventually gained command of the sea and won both wars via a sea-LOC from the new world to Europe

Finally, Mahan's theory illustrates one of the earliest understandings of the supply chain in an industrial society, i.e. the link between resources, industry, and transportation to market in peacetime and the link between military power and transportation to battle in wartime. However, by downplaying technology, Mahan's theory is ill equipped to explain precisely the tactical and operational dynamics at play in using the sea as a strategic medium of communication.

Mahan 101

...there sea power can most firmly establish itself... where commerce, the energizer of material civilization, can work to greatest advantage, and also can most certainly receive the support of the military arm of sea-power. (Mahan 1900, 296)

A. T. Mahan

Mahan looked out in the late 19th century and saw one world hegemon—Great Britain. The island empire emerged from the state of shifting wars, economic upheavals, and quests for new colonies from the 17th through the 18th centuries as the dominant global power. In advocating for his own nation to join the ranks of world powers, Mahan examined this period of upheaval in his classic *The Influence of Sea power Upon History: 1660-1783*, to determine what had made Britain such a dominant state. In most aspects of British power, Mahan saw the sea.

Mahan's sea power theory has three intertwining branches—economic, political, and military. The economic benefits of strong overseas trade boost a nation's internal and external political power.² In order to protect the overseas trade routes, a nation requires a robust navy "to secure to one's own people a disproportionate share of such benefits."³ In turn, the strength of the navy relies on "the peaceful commerce and shipping from which alone a military fleet naturally and healthfully springs and on which it surely rests."⁴ Thus, economic, political, and military powers rely on each other in direct proportion. Britain personified this interrelationship during the age of sail, and her navy and economic successes cannot be studied in isolation.⁵

Lines of Communication

Communications dominate war; broadly considered they are the most important single element in strategy, political, or military.

A. T. Mahan.

The great promise for the sea as a commerce medium lies in its character as a "great highway; or better, perhaps, of a wide common, over which men may pass in all directions."⁶ The common's freedom of movement is in stark contrast to the geographical difficulties of land travel during the 17th and 18th centuries. Mahan sums up land travel during that time as expensive, inefficient, and dangerous due to poor roads and continual land warfare.⁷ Mahan's "great highway" gives nations freedom to trade in a globalized market place, the true prize. For

² Mahan, *The Influence of Sea Power*, 1.

³ Mahan, *The Influence of Sea Power*, 1.

⁴ Mahan, *The Influence of Sea Power*, 23.

⁵ Paul M. Kennedy, *The Rise and Fall of British Naval Mastery* (Atlantic Highlands: Macmillan, 1983), xxvii.

⁶ A. T. Mahan and John B. Hattendorf, *Mahan on Naval Strategy : Selections from the Writings of Rear Admiral Alfred Thayer Mahan*, Classics of Sea Power (Annapolis, Md.: Naval Institute Press, 1991), xix; *ibid.*, 27.

⁷ Mahan, *The Influence of Sea Power*, 23

Mahan, internal commerce does not offer the high rewards of overseas trade.⁸

Mahan's thought on LOCs contains two parts: civilian commerce and military power projection.⁹ The ocean's *Res Cominus* nature allows these two spheres to exist in a medium of free movement. Unlike the land, the sea presents few barriers to free use. Only the geography of access controls the terms. However, in order to move goods to market or military forces to combat, nations tend to travel over "well-worn paths" representing the safest and quickest routes between land destinations, what Mahan describes as "trade routes."¹⁰

Protecting trade routes requires both a naval force and the possession of critical positions from which to launch and supply naval operations. The most important positions are those that allow access to the open ocean while also controlling trade. Mahan observed that Britain possessed such a critical area in the English Channel during the 17th and 18th Centuries. Because of the channel, the British both controlled trade into Europe and had unobstructed access to the broader Atlantic Ocean.¹¹ Thus, when advocating for his own country, Mahan places heavy emphasis on geographical position—most importantly the Panama Canal for the same reasons. Mahan views the Panama Canal as the critical link to establish the Caribbean as a great trading region resembling the Mediterranean.¹²

Although Mahan considers both military force and position, he assigns them unequal weight in his linear calculation of military sea power, "in the combination of the two factors, force and position, force is intrinsically the more valuable, it is always possible that great advantage of position may outweigh small advantage of force, as 1 + 5 is greater

⁸ Mahan, *The Influence of Sea Power*, 23

⁹ Mahan, *The Influence of Sea Power*, 26-27.

¹⁰ Mahan, *The Influence of Sea Power*, 24.

¹¹ Mahan, *The Influence of Sea Power*, 31-32.

¹² Mahan, *The Influence of Sea Power*, 33.

than 2 +3.”¹³ Mahan furthers places value upon force by conflating force with position “the sea is not without positions advantageous to hold...The fleet it may be said is itself the position.”¹⁴

Mahan bases naval power on the ship-of-the-line and battle fleets. He extols the virtue of nations, who have large battle fleets, and points to the failures of those such as France in the 1660s, which allowed its fleet to atrophy to “only thirty ships of war, of which only three had as many as sixty guns.”¹⁵ Despite his ahistorical view of sea power and technology, generally, Mahan recognizes the technological prowess of the ship-of-the-line. It is the technology of the large ships of war that allows them to range longer and bring greater firepower to bear than any smaller boat could match.¹⁶

Although Mahan regales the fleet, support from land bases underpins his sea power. Even large wooden cruisers, which could sail for months at a time, required refueling and replenishment.¹⁷ In addition, naval forces could not be everywhere. For Mahan this is especially true for operations far from home bases. In a nod to Clausewitz’s culminating point and Jomini’s maxim that “you cannot hope to control the whole field,” Mahan acknowledges operations deep into enemy territory are desirable, but come at a cost to weakening internal LOCs.¹⁸

¹³ Mahan and Hattendorf, *Mahan on Naval Strategy*, xxv-xxvi.

¹⁴ Mahan and Hattendorf, *Mahan on Naval Strategy*, 155.

¹⁵ Mahan, *The Influence of Sea Power*, 70.

¹⁶ Mahan, *The Influence of Sea Power*, 5, 72, and 369. The diagram on page 369 shows the French and English in battle off the coast of Grenada in July of 1779. The diagram dramatically illustrates the prevalence of the ships-of-the-line versus smaller convoy ships during the time of Mahan’s analysis.

¹⁷ Mahan, *The Influence of Sea Power*, 27-28.

¹⁸ Mahan and Hattendorf, *Mahan on Naval Strategy*, 106.; Carl von Clausewitz, Michael Howard, and Peter Paret, *On War* (Princeton, N.J.: Princeton University Press, 1984), 528. For Clausewitz the culminating point is “the point the scale turns [for the offense] and the reaction [from the defense] follows with a force that is usually much stronger than that of the original attack.” Mahan bases his theories on Jomini’s more linear concepts of war by position, but nonetheless possesses a Clausewitzian understanding of what pushing LOCs too far forward can mean for sea power.

Mahan illustrates the powerful combination of fleet and position through his map of the British Empire in the Atlantic below (Figure 2). Naval operations sailed out from home basing, the British Isles, to worldwide ports, with access to and control of critical chokepoints on the “well-worn paths” of world commerce.¹⁹ Due to its location on the English Channel, Britain could control trade out of Germany and the Netherlands. At the same time, the British fleet had unfettered access to the North America, the Caribbean, and South Africa from whence they would branch out to India and the Pacific Ocean.

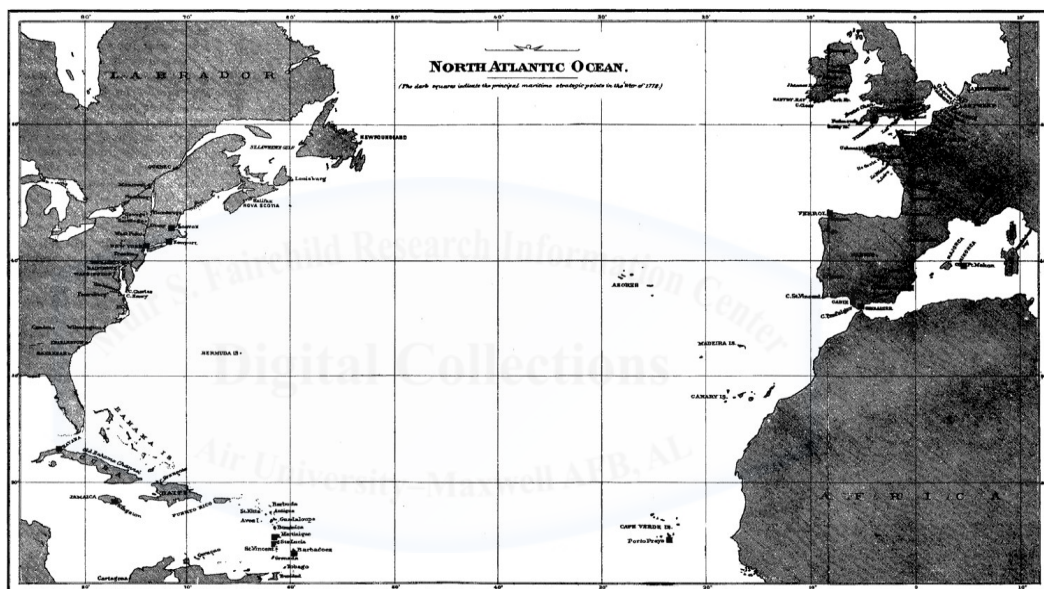


Figure 2: The British Empire and the Atlantic Ocean

Source: A.T. Mahan, *The Influence of Sea Power Upon History*

Mahan’s vision is perhaps noticeable more for what it is not than for what it is. It belies a spirit of global economic cooperation and accentuates the pure extraction of wealth by individual states. He wrote only thirty years after Darwin and shared a like-mindedness with Herbert Spencer. There are, however, a few egalitarian notes in his symphony of national survival. In order to protect commerce (in Mahan’s case British commerce), world commerce is also protected. In other words, Britain

¹⁹ Mahan, *The Influence of Sea Power*, 25.

and by extension sea power, protects not only one nation's trade routes, but all trade routes, "for without the trade routes, the navy experience showed that his navy was like a growth which having no root soon withers away."²⁰

Mahan has negative views of nations, such as Spain, which extracted the resources of colonies, without proper concern for protection of world trade routes. He states, "If history may be believed, the way in which the Spaniards and their kindred nation, the Portuguese, sought wealth, not only brought a blot upon the national characters, but was also fatal to the growth of a healthy commerce...and ultimately to that national wealth which was sought by mistaken paths."²¹ In an early nod to subsequent economic globalization theories, Mahan posits that increasing economic power of world commerce lanes, increases national prosperity—especially for the enforcers of free trade.²²

In summary, for Mahan lines of communication were a key component to sea power with "the navies, as the guardians of the communications...the controlling factors in war."²³ Mahan believed sea control, gained through a ship-of-the-line fleet, gave a nation five distinct advantages. First, the state could conduct commerce in a manner it sees fit. Second, it could deny other nations the same ability to conduct commerce.²⁴ Third, sea control provided a country the ability to blockade enemy ports (as opposed to commerce destroying, which Mahan believed has only transient effects).²⁵ Fourth, command of the sea gave a state the ability to bombard enemy coastlines.²⁶ Finally, control of the

²⁰ Greg Russell, "Alfred Thayer Mahan and American Geopolitics: The Conservatism and Realism of an Imperialist," *Geopolitics* 11, no. 1 (2006): 128.

²¹ Mahan and Hattendorf, *Mahan on Naval Strategy*, 53.

²² A.T. Mahan, "Effects of Asiatic Conditions Upon International Policies," *The North American Review* 171, no. 528 (1900): 619.

²³ Mahan, *The Influence of Sea Power*, 529.

²⁴ Mahan, *The Influence of Sea Power*, 531.

²⁵ Mahan, *The Influence of Sea Power*, 87. Mahan worries that the US, without a strong Navy, will be blockaded, thus denying the nation critical commerce.

²⁶ Mahan, *The Influence of Sea Power*, 296.

sea allowed for the conduct of amphibious operations whose precision and speed land forces could not match.²⁷ In Mahan's own words, "the navy is essentially a light corps, it keeps open the communications between its own ports, it obstructs those of the enemy; but it sweeps the sea for the service of the land, it controls the desert that man may live and thrive on the habitable globe."²⁸

Mahan Evaluates Technology

*It is questionable if all the mechanical inventions yet
made have lightened the day's toil of any human being*

John Stuart Mill

Mahan had an ahistorical view of technology. He believed "the principles which should direct naval combinations have been applicable to all ages, and are deducible from history."²⁹ Despite the primacy of steam ships, which Mahan readily acknowledged changed many tactical considerations, and the pervasiveness of railroads by the late 19th century, Mahan viewed sea power as immune to technological change. To understand how he viewed technology and its impact upon sea power, a brief look into the development of Mahan's theory of sea power is in order.

While on an extended duty in South America, Mahan happened upon the library of the English Club in Lima Peru. In the library, Mahan poured over Theodor Mommsen's *History of Rome*.³⁰ According to Greg Russell in his article "The Influence of Mahan," "Mahan was struck by 'how different things might have been could Hannibal have invaded Italy

²⁷ Mahan, *The Influence of Sea Power*, 15 and 387-389. Mahan illustrates how the Romans were able to conduct amphibious operations behind Hannibal's LOCs through their control of the Mediterranean Sea. Mahan also describes the French bottling up of Cornwallis at Yorktown as an example of both amphibious operations (the fleet initially dropped off French troops to help the operation) and then blockage (the French prevented the British from escaping out to the Atlantic while simultaneously keeping the British out of the Chesapeake).

²⁸ Mahan, *The Influence of Sea Power*, 329.

²⁹ Mahan, *The Influence of Sea Power*, 22.

³⁰ Russell, "Alfred Thayer Mahan," 124.

the by sea, as the Romans had Africa.”³¹ Thus, Mahan begins *The Influence of Sea Power*, not with British mastery of the seas, but with a detailed explanation of how Roman sea power beat Carthaginians land power. He states, “Had the Mediterranean been a level desert of land, in which the Romans held strong mountain ranges in Corsica and Sardinia...and Allied fortresses in the Marseilles and other points; had they also possessed an armed force capable by its character of traversing that desert at will...the military situation would have been at once recognized, and no words would have been too strong to express the value and effect of that peculiar force.”³²

In this statement, Mahan blends the critical operational elements of his theory—adequate military force and sufficient base support (position) into one statement. Mahan’s first map in *The Influence of Sea Power* depicts the situation during the Punic Wars. This map is at Figure 3. When compared to Mahan’s larger depiction of the British Empire at the close of the 18th century (See Figure 1), the same two concepts of force and position apply.

³¹ Russell, “Alfred Thayer Mahan,” 124.

³² Mahan, *The Influence of Sea Power*, 20.

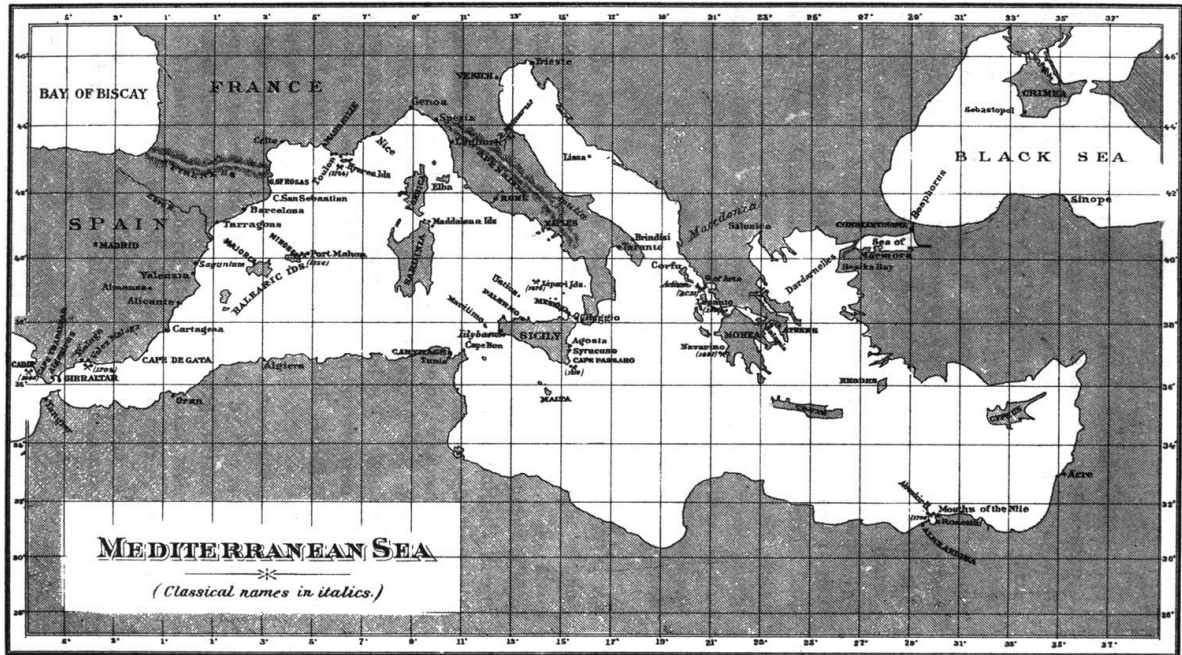


Figure 3: Mahan's Mediterranean Map of the Punic Wars

Source: A.T. Mahan, *The Influence of Sea Power Upon History*

When viewed together, these maps explain why Mahan is reluctant to consider technological change. In both projections, geography and position trump other factors in the equation of geopolitics. If global commerce routes pass over well-worn routes, and water transportation is cheaper than land, then the only way to control the sea is through a robust fleet and fixed refueling points to ensure the safe passage of commerce. Mahan could not imagine a technology changing these basic factors. For him, a nation's greatness was rooted in geography, and the ability to control the sea was both the destiny and desideratum of a great power.

As aforementioned, Mahan does consider technological change—even those technologies like the square-rigged sail, rudder, sextant, and chronometer that did much to establish the paradigmatic dominance of the wooden sailing ship between 1666 and 1783. He has several discussions in *The Influence of Sea Power*, comparing the new steam

ships to the galley ship of old. Mahan considers their most salient similarity “the ability to move in any direction independent of the wind.”³³ Mahan also mentions rail transport, but only as a technology for internal trade and considers it a poor substitute for the wealth brought by sea trade.³⁴ Finally, in a nod to the future sea battles of the twentieth century, Mahan views the submarine not as a threatening menace to future LOCs, but only as an extension of “torpedo warfare.”³⁵

In Mahan’s examination, he concludes that technology does not alter LOCs. During his research for *The Influence of Sea Power*, Mahan lamented the fascination of his peers with “iron-clads, rifled guns, and torpedoes.”³⁶ Mahan wanted to look back to the age of sail “to relate questions about naval power to larger political and economic issues.”³⁷ Thus, Mahan believed technology might change some of the tactical characteristics of sea power, but not overturn his six key strategic elements of sea power: Geographic Position, Physical Conformation, Extent of Territory, Number of Population, Character of the People, and Character of the Government.³⁸

With Mahan’s penchant for the past, his analysis misses many of the technologies that had already changed much of sea power by the time he had written *Influence*. For example, the shell gun had already rendered Mahan’s revered sailing ships obsolete for combat by the late 19th century. Steam propulsion greatly complicated the dynamics of blockade, as did long-range coastal artillery and mines. At the same time, railroads did for internal communications what the ship had done for those external to a nation’s shorelines and borders. Britain and Germany were already in a shipbuilding race, not of wood, but of steel

³³ Mahan, *The Influence of Sea Power*, 2.

³⁴ Mahan, *The Influence of Sea Power*, 86.

³⁵ Mahan and Hattendorf, *Mahan on Naval Strategy*, xxx.

³⁶ Russell, “Alfred Thayer Mahan,” 124.

³⁷ Russell, “Alfred Thayer Mahan,” 124.

³⁸ Mahan, *The Influence of Sea Power*, 28-29.

during Mahan's time. By the end of the First World War, even these dreadnoughts were put at risk by the submarine and the airplane.

Engine technology was also changing in Mahan's time. The steam engine that powered both sea and rail was slowly giving way to the internal combustion engine. According to Daniel Yergin in *The Prize*, as early as 1911, a British Admiral told Winston Churchill, "a cargo steamer could 'save 78 percent in fuel and gain 30 percent in cargo space by the adoption of the internal combustion propulsion and practically get rid of stokers and engineers.'"³⁹ With greater efficiency in turn, ships powered by the combustion engine could open up markets not available to coal steamers. Thus, by the turn of the century there was growing awareness that the internal combustion engine could change ocean-borne LOCs.⁴⁰

Technological development and subsequent impact on LOCs would not confine itself to the sea. Under Mahan's thesis, the sea granted the easiest and cheapest way to traverse regions.⁴¹ His theory does not account for a world in which land transportation would compete with seaborne commerce. Halford Mackinder understood this and would offer much to change Mahan's map of the world. Ultimately, in both World War I and World War II, the technologies of the railroad and the airplane would challenge Mahan's views of LOCs.

³⁹ Daniel Yergin, *The Prize : The Epic Quest for Oil, Money, and Power* (New York: Simon & Schuster, 1991), 155.

⁴⁰ James J. Corbett and James Winebrake, "The Impacts of Globalisation on International Maritime Transport Activity," in *Global Forum on Transport and Environment in a Globalising World* (Guadalajara, Mexico: Organization for Economic Co-operation and Development, 2008), 10.

⁴¹ Mahan and Hattendorf, *Mahan on Naval Strategy*, 27.

Mahan Today

Who can guess the secret of the sea?

Wilco

While unable to appreciate how technology would change communications and global logistics, Mahan did understand that the industrial revolution's technological advances reshaped the world economy. In a nod to future supply chain management concepts he believed the economy of a seafaring nation revolves around "three things—production, with the necessity of exchanging products, shipping, whereby the exchange is carried on, and colonies, which facilitate and enlarge the operations of shipping and tend to protect it by multiplying points of safety."⁴² With his integrative view of manufacture (production), logistics (shipping), and sales (exchange), Mahan espouses a Supply Chain Management view only fully realized a century after his writing. As Fawcett, Elram, and Ogden state in *Supply Chain Management: From Vision to Implementation*, "Since the dawn of the industrial age, companies participated as members of one or more supply chains—buying inputs, making products, and selling these products to customers. Until recently, the interdependencies among these diverse companies have been largely ignored."⁴³ Despite his reduced view of technology, Mahan understood modern commerce, and the role the military plays in keeping it open, far better than many nations and international firms would for nearly a hundred years.

With his nuanced view of commerce, Mahan also laid the groundwork for future theories about the rise of the global corporation. In his theory, the state, naval power, and commerce intertwine, but the state and navy cannot wholly control commerce. In fact, "when for any reason the sea trade is again found to pay, a large enough shipping

⁴² Mahan, *The Influence of Sea Power*, 28.

⁴³ Stanley E. Fawcett, Lisa M. Ellram, and Jeffrey A. Ogden, *Supply Chain Management : From Vision to Implementation* (Upper Saddle River, NJ: Pearson Prentice Hall, 2007), 16.

interest will reappear to compel the revival of the war fleet.”⁴⁴ The state through its naval power must then create the highway in the sea for “along this path the great commerce will travel,”⁴⁵ Mahan has an implicit faith that commerce will follow transportation routes.

Since Mahan gives power to commerce, his writing sounds much like the “spaces of flows” (i.e. businesses and international commerce) and “spaces of places” (i.e. nation-states) literature used today to describe global corporations. Giovanni Arrighi, in *The Long Twentieth Century*, builds to “flows” and “spaces” by asking the following, “Is Capitalist History about to end through the formation of a truly global empire based on...force of the West as Max Weber seemed to envisage or is it going to end through the formation of a world market in which the superiority of the West withers away as Adam Smith seemed to envisage?”⁴⁶ Thus, with his simple and elegant theory, Mahan understood much of what sustained and built the global economy.

If Mahan’s views of military sea power protecting commerce are right, there must be some signs in a global market that currently carries 55% of all goods by sea.⁴⁷ In Figure 4 below, the skewed world projection represents port capacity worldwide. China and the United States contain the two largest port capacities in the world. They also field the first and second largest navies in the world.⁴⁸ Finally, the two economies

⁴⁴ Mahan, *The Influence of Sea Power*, 28.

⁴⁵ Mahan, *The Influence of Sea Power*, 33.

⁴⁶ Giovanni Arrighi, *The Long Twentieth Century : Money, Power, and the Origins of Our Times*, “New and updated ed. (London ; New York: Verso, 2010), 23.

⁴⁷United States Department of Transportation, *Freight Transportation: Global Highlights 2010*, Washington DC:2010, 5. 55% of all goods in internal and external trade worldwide travel by sea.

⁴⁸ Global Fire Power, “Total Navy Ship by Country” www.globalfirepower.com/navy-ships.asp (accessed February 15 2012). This number contains all navy ships and does not differentiate between mission and platform. The Chinese Navy works more on a regional basis, while the US Navy deploys worldwide. However, both navies patrol the precarious Straits of Malacca and have a large presence in the Indian Ocean patrolling against Somali pirates.

comprise nearly 30% of the world's Gross Domestic Product (GDP).⁴⁹ Adding Japan, Europe, and India to the equation only strengthens Mahan's argument. Although they comprise not the only elements of national power, the Mahanian correlation between naval strength, commercial benefit, and state power still holds.

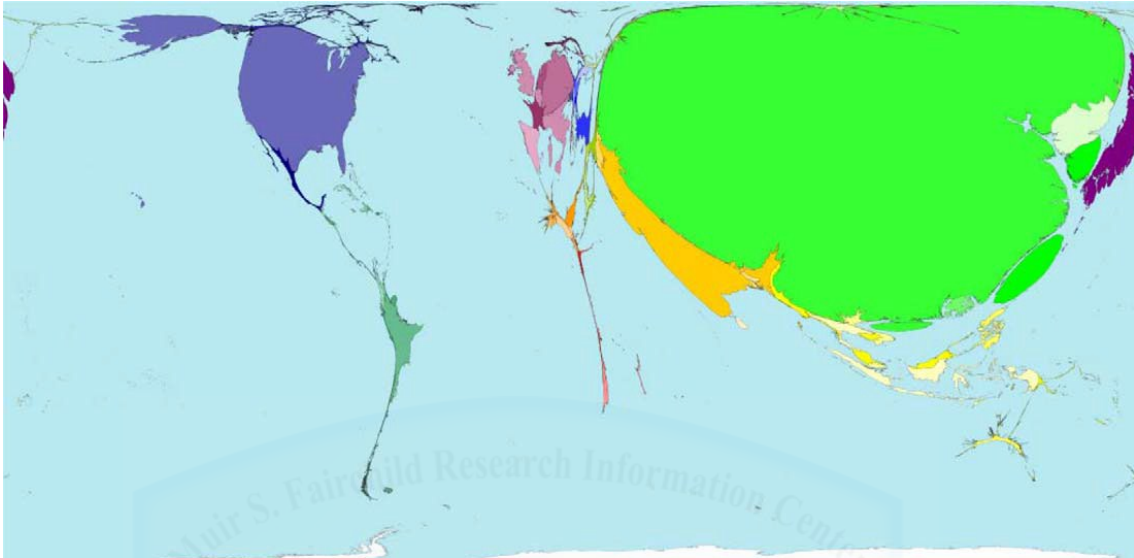


Figure 4: Cartogram of container port capacity worldwide

Source: Jon Shaw and James Sidaway, "Making Links: On (Re)Engaging with Transport and Transport Geography."

Mahan's theory also has explanatory power for those regions of the world that are not economically powerful. In Figure 4, Africa possesses only a sliver of total port capacity, while Brazil has the only significant port power in South America. Thus, the lack of sea commerce indicates lack of global economic competitiveness and a corresponding lack of military power. In this vein, Mahan is right. However, without the internal trade and LOCs established on land, many of the regions with the geographic position for seaborne trade and the physical conformation

⁴⁹ World Bank, "Worldbank Indicator Data" <http://data.worldbank.org/indicator> (accessed 5 December 2011).

for port capacity lack the necessary internal commerce to get their products to port. Future technologies may change this.

Given Mahan's retrospective theory, any discussion of global LOCs must include his thoughts. His critical speculations of the relationship between commerce, naval capability, and state power in many ways hold true to this day. Moreover, the interrelationship of internal and external LOCs is vital to his geopolitical formulations. However, his ahistorical look at sea power led him to discount technology as an important element in the development of sea lines of communication.



Chapter 2

Locomotion for the Admiral's Ocean: Halford Mackinder, Land LOCs, and Rail Power

The production of motion in the steam engine always occurs in circumstances which it is necessary to recognize, namely when the equilibrium of caloric is restored, or (to express this differently) when caloric passes from the body at one temperature to another body at a lower temperature.

Sadi Carnot

The Second Law of Thermodynamics and the World System

As Mahan was writing his *magnum opus* at the turn of the nineteenth century, the railroad had already reached its peak as the world's land transportation device. While Mahan looked wistfully to the past to define his principles of sea power, Halford J. Mackinder, a British geographer looked upon the steam engine, embodied in the railroad, as the great equalizer in the competition between sea and land.

The steam engine, created first technically feasible form by John Newcomen and made mobile by James Watt in the late 18th century, took decades of refinement to make it efficient enough for transportation power.¹ Early steam engines were so heavy and inefficient there was practically no way to move them.² When the steam engine first found use as a movement technology it was upon Mahan's most efficient transportation medium—the water—it was first used. In 1807, Robert Fulton's demonstration that steam could power a ship "proved that it was possible for humans to alter artificially where they were, and when they were there, to practical effect."³ The railroad developed in the

¹ Robert Henry. Thurston, "A History of the Growth of the Steam-Engine," (New York: D. Appleton and Company, 1878).
http://books.google.com/books/about/A_History_of_the_Growth_of_the_Steam_eng.ht
[ml?id=VDgOAAAAYAAJ](http://books.google.com/books/about/A_History_of_the_Growth_of_the_Steam_eng.ht) (accessed 1 May 2012).

² John Laurence Busch, "Steamboat Design During the First Generation," *Mechanical Engineering* 134, no. 1 (2012): 68. The cylinders on mine steam engines were as large as six feet each by the end of the 18th century.

³ John Laurence Busch, "Steamboat Design," 36-37.

decades following, combining the steam engine with improved rail-line technology already in use (horses were already pulling rail-fit carriages) to make transportation more efficient.⁴ While sea transportation quickly traded its sails for steam, land transportation traded slow and tedious wagon travel for trains in under a century. The railroad and the steam ship irrevocably altered commerce and war, propelling armies and navies faster and further than ever before, while simultaneously connecting the battlefield to national industry and home populations. Mackinder understood this inter-relationship between technology and transportation and the methods of national power projection: land versus sea.

Mackinder single-handedly created geopolitics—the study of geography’s impact on nation states—at the turn of the 19th century. His powerful integrative analysis that, “define[s] geography as the science whose main function is to trace the interaction of man in society and so much of his environment as varies locally” serves as an intellectual baseline for all future geopolitical study.⁵ His influence on international relations, supply chain management, and even such diverse fields as space policy and history is considerable.⁶ Most notoriously, Mackinder influenced such German thinkers as Karl Haushofer who provided intellectual weight to Hitler’s *Lebensraum*.⁷ Academics, policy-makers,

⁴ Thurston, “A History,” 181.

⁵ Halford J. Mackinder, “On the Scope and Methods of Geography,” *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 9, no. 9 (1897): 142.

⁶ David J. Keeling, “Transportation Geography: Local Challenges, Global Contexts,” *Progress in Human Geography* 33, no. 4 (2009). In a supply chain/commercial industry example, Keeling gives a nod to Mackinder’s definition of geography, “Although sophisticated interconnected global networks have evolved...transportation is always grounded in the local!” For an example of space policy see, Everett C. Dolman, *Astropolitik : Classical Geopolitics in the Space Age*, Cass Series--Strategy and History (London ; Portland, OR: Frank Cass, 2002)., 39-41.

⁷ Kearns, *Geopolitics and Empire: The Legacy of Halford Mackinder* (New York: Oxford University Press, 2009), 16. Kearns states, “Haushofer claimed that his work on Geopolitics developed further ideas of a number of...writers, including Mackinder.” Kearns offers a broad critique of Mackinder in general. For a defense of Mackinder see Brian W. Blouet, *Global Geostrategy : Mackinder and the Defence of the West*, Geopolitical Theory Series (London ; New York: Frank Cass, 2005).

and world militaries cannot think about political power on a map without Mackinder.

Moving beyond those in his day who focused on the closing races to Empire or regional geographic concerns, Mackinder looked to the future and to the world map.⁸ In this future, he saw the rise of land-power given the technological requirements of an industrial economy and the technological transportation capabilities bequeathed by the same.

During Mackinder's intellectual journey to determine the relationship between geography and world political power, the great nations of the world had already conquered the globe. In 1897, he remarked, "The natural result is that we are now near the end of the roll of great discoveries, the Polar Regions are the only large blanks remaining on our maps. A Stanley can never again reveal a Congo to the delighted world"⁹ With the world closed, it was time to reflect: "we are for the first time in a position to attempt, with some degree of completeness and correlation between the larger geographical and larger historical generalizations."¹⁰ In order to glean overarching themes, Mackinder conceptualized the closed system and applied it to geography.

The closed system, fully realized in the scientific realm of Mackinder's time through the maturation of the Second Law of Thermodynamics, represents a useful metaphor for Mackinder's analysis.¹¹ According to the Second Law of Thermodynamics, in a closed system, the transfer of energy from one region to another involves a

⁸ Mackinder, "On the Scope and Methods of Geography," 142. At the turn of the century, Mackinder debated those in his time such as Sir Frederic Goldsmid who considered geography best studied as a separate field. Goldsmid said, "It is difficult to reconcile the amalgamation of what may be considered 'scientific' geography with history. One is as thoroughly apart from the other as geology is from astronomy."

⁹ Mackinder, "On the Scope and Methods of Geography," 141.

¹⁰ Halford J. Mackinder, "The Geographical Pivot of History (Reprint of 1904 Article)," *The Geographical Journal* 170, no 4., 2004, 422; Mackinder, "On the Scope and Methods of Geography," 141.

¹¹ Kearns, *Geopolitics and Empire*, 132. After a journey to climb Mount Kenya in 1899 Mackinder stated, "We now have a closed circuit—a machine complete and balanced in all its parts. Touch one and you influence all."

change to the entire system. Most importantly, this transfer results in less total energy left over in the system.¹²

When applied to Mackinder's geographical construct, the Second Law of Thermodynamics has two consequences. First, any change in any part of the world system will affect the whole system. As Mackinder states, "we now have a closed circuit—a machine complete and balanced in all its parts. Touch one and you influence all."¹³ Second, the only way to change the world system is to input energy into or take energy out of the system. For Mackinder the energy transfer takes place in terms of military conquest and technological development for a "single mechanical discovery may affect the change."¹⁴ Those technologies such as the telegraph, the railroad, and in his much later analysis, the airplane serve to change the system. Mackinder's theory thus makes geostrategic concerns and lines of communication (LOCs) very sensitive to technological change.

For Mackinder, land power represents the ultimate political prize. Any shift in power between nations naturally takes place on the land. Geographical makeup—oceans, deserts, mountains, rivers, or forests—in turn, underscore political success or failure. He says, "I have spoken as a geographer. The actual balance of political power at any given time is, of course, the product, on the land, of geographical conditions...and, on the other hand...the competing peoples." Thus, geography and the technological tools used to overcome it form the *Zeitgeist* of a nation.

¹² Frans P. B. Osinga, *Science, Strategy and War : The Strategic Theory of John Boyd, Strategy and History* (London ; New York: Routledge, 2007), 23. See also Gerry Kearns, *Geopolitics and Empire: The Legacy of Halford Mackinder* (New York: Oxford University Press, 2009), 131-137. Kearns details Mackinder's view of the world as a closed system in terms of commerce and finance. In essence, since commercial exploitation of world resources was a fixed amount in a closed system—capital flows would be a new avenue for exploitation.

¹³ Quoted in Kearns, *Geopolitics and Empire*, 132 from Halford J. Mackinder, "The Great Trade Routes. (Their Connection with the Organization of Industry, Commerce, and Finance.)," *Journal of the Institute of Bankers* 21, no. (1900): 271..

¹⁴ Mackinder, "On the Scope and Methods of Geography," 152.

Mackinder's Map

Mackinder divides the world into three major areas—the pivot area, the inner or marginal crescent, and the outer or insular crescent (See Figure 5). The pivot area represents the crucial area for world political history. The pivot area is composed of the steppes extending from Eastern Europe to the Gobi desert from West to East and from the arctic in the North, to the Caucasus below the Caspian Sea and the Himalayas to the South.

Mackinder builds the pivot area from historical analysis. In wave after wave, from Attila the Hun to the Mongols, nomadic peoples drove through the pivot to invade Europe and Asia located in the marginal crescent. Such invasions made “Europe and European history as subordinated to Asia and Asiatic history, for European civilization is, in a very real sense, the outcome of the secular struggle against Asiatic invasion.”¹⁵ The nomadic power of the east held the west in check. In response to these nomadic invasions, Western Europe naturally turned towards the sea and eventually conquered most of the world.

¹⁵ Mackinder, “The Geographical Pivot,” 432.

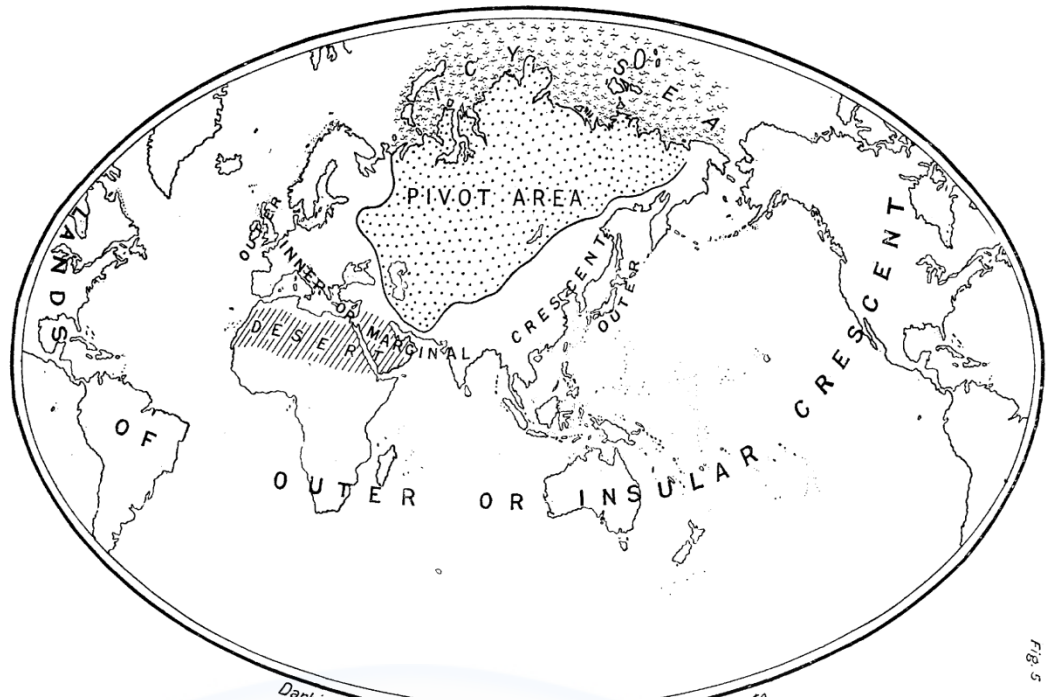


Figure 5: Mackinder's Map 1904

Source: Halford J. Mackinder, "The Geographical Pivot Point."

The pivot area represents world power, not only in the past, but also for the future. Mackinder states, "As we consider this rapid review of the broader currents of history, does not a certain persistence of geographical relationship become evident? Is not the pivot region of the world's politics that vast area of Euro-Asia which is inaccessible to ships, but in antiquity lay open to the horse-riding nomads, and is today about to be covered with a network of railways?"¹⁶ As Mackinder further refined his analysis over time, he changed the nomenclatures of his chosen region from pivot to "The Heartland." This syntactic change moved the region from mere description in the word pivot, to the metaphorical blood-pumping engine of the world.¹⁷

¹⁶ Mackinder, "The Geographical Pivot," 434.

¹⁷ Halford J. Mackinder, *Democratic Ideals and Reality: A Study in the Politics of Reconstruction* (New York: Henry Holt, 1919), 88. In time, Mackinder would further tie the Heartland, Europe, and Africa into one large world island. He does this after World War I. See Chapter 4 "Air Power and the Inter-War Years" in this thesis for a further elaboration of the ideas in *Democratic Ideals and Reality*.

The Heartland contains vast tracks of flat land and abundant natural resources. These attributes make the Heartland the perfect region to grow food, develop manufacturing, and use the mobility of the railroad to tie the region together into a modern industrial powerhouse.¹⁸ In terms of resources, “the spaces within the Russian Empire and Mongolia are so vast, and their potentialities in population, wheat, cotton, fuel, and metals so incalculably great, that it is inevitable that a vast economic world, more or less apart, will there develop.”¹⁹ The Heartland’s geography lacks large mountain ranges, dense forest, or significant bodies of water, making it favorable for fast land transportation—from ancient nomadic tribes to modern railroads.²⁰

Just beyond the Heartland is the inner or marginal crescent. The inner crescent represents the modern industrial powers such as France, Germany, Austria, and Italy, which hem in the Heartland from the west.²¹ The marginal crescent also continues along the same Axis to the east covering areas of the world controlled by outsiders, generally great sea powers “where local power is, at present, more or less negligible.”²²

Encircling the inner or marginal crescent is the outer or insular crescent. Sea-faring nations, such as Britain and the United States dominate the outer crescent. In general, the Heartland is inaccessible to the outer crescent and by extension great sea commerce.²³ Mackinder uses the term “insular” to describe the relationship of the outer crescent to the metaphorical world center. The sea powers cannot reach the great Heartland, and the land power of the Heartland cannot yet reach the sea powers.

¹⁸ Mackinder, *Democratic Ideals*, 171.

¹⁹ Mackinder, “The Geographical Pivot,” 434.

²⁰ Mackinder, “The Geographical Pivot,” 431.

²¹ Mackinder, “The Geographical Pivot,” 436-437.

²² Mackinder, “The Geographical Pivot,” 437.

²³ Mackinder, “The Geographical Pivot,” 433.

Mackinder and Lines of Communication

Mackinder's contention that any change in one region of the world harkens to change elsewhere carries over to his view of LOCs. In dynamic fashion, Mackinder views land and sea communications in a continuing dialectic. Although Mackinder considers land communications—especially those of the Heartland—as the dominant LOCs for the future, he does so only in relation to sea power. The Heartland's ultimate advantage is the lack of “available water-ways to the ocean, but, on the other hand, except in the subarctic forest, are very generally favorable to the mobility of horsemen and camelmén.”²⁴ This type of analysis fits with Darwinian concepts popular during Mackinder's time.²⁵ Lines of Communication, much like Darwin's biological world, must adapt or die. In turn, the Heartland needed insularity from sea power to be able to grow and survive. Thus, the land and sea LOCs are in continual competition, waiting for possible technological improvement, climatic transformation, or political change to assume dominance.²⁶

The mobility properties of land and sea communications make them close relatives. While Mahan underpins his sea power with the speed and efficiency of the sea LOC, Mackinder believes railroads provide the same advantage for the land LOC. Mackinder notes the Russian “railways have a clear run of 6000 miles from Wirballen in the west to Vladivostok in the east. The Russian army in Manchuria is as significant evidence of mobile land-power as the British army in South Africa was of sea-power.”²⁷ Since at the turn of the nineteenth century, British sea power required sea bases along the route to South Africa, while the

²⁴ Mackinder, “The Geographical Pivot,” 431.

²⁵ Kearns, *Geopolitics and Empire*, 63. Kearns explores Darwinian concepts used by Mackinder and his contemporaries in detail.

²⁶ Andrea Charron, “Northwest Passage: Is Canada's Sovereignty Floating Away?,” *International Journal* 60, no. Summer 2005 (2005): 831. One possible implication of future climate change is the opening up of the ice in the Northwest Passage. This would greatly reduce transoceanic shipment times from Asia to Europe and likely shift world geopolitics as well.

²⁷ Mackinder, “The Geographical Pivot,” 434.

Russians needed no such protection in their internal Heartland, the advantage goes to land power.²⁸

The land power LOC continues its dominance over the sea in terms of conflict between the two. Mackinder posits that a modernizing Russia can use her railways to “strike on all sides” while also responding to “attack from all sides.”²⁹ The same land power, if ever coupled with Germany “should, therefore, throw France into alliance with the over-sea powers, and France, Italy, Egypt, India, and Corea[sic] would become so many bridge heads where the outside navies would support armies.”³⁰

This is not to indicate the Mackinder believes land power could overcome sea power in any specific instance. He is careful to place the Heartland outside of sea power’s reach for this reason. Mackinder understands that if sea power could reach the Heartland, it would cease to be such a critical area.³¹

In his continuing interplay between sea and land LOCs, Mackinder flips the insularity of the Heartland back onto the sea powers of the late nineteenth century. He understands the Heartland cannot reach out and envelop the sea powers. Because the Heartland has no outlet to the sea, the maritime powers have great freedom of movement around the Heartland. Even the United States, as a newly rising world power with a Pacific fleet could influence “the European balance not directly, but through Russia [and by extension the Heartland], and she will construct the Panama Canal to make her Mississippi and Atlantic resources

²⁸ Mackinder, “The Geographical Pivot,” 434.

²⁹ Mackinder, “The Geographical Pivot,” 436.

³⁰ Mackinder, “The Geographical Pivot,” 436.

³¹ Mackinder, “The Geographical Pivot,” 431. Mackinder describes the consequences of laying too near sea power for nation-states and empires. In particular, he notes the Babylonian and Egypt empires were too close to the sea lines of communications and suffered egregiously, “But, as we should expect, these empires have been subject to an unparalleled series of revolutions, some due” to overland empires and “others to the effort of the Mediterranean peoples to conquer the overland ways from the western to the eastern ocean.”

available in the Pacific.”³² Mackinder realizes the conundrum his Heartland faces; it has much needed insularity for internal economic development, but also lacks mobility to the rest of the world and hence loses both market and political opportunities.

Mackinder has a solution for this problem. Harkening back his contention that political or technological could change the world balance of power, he chooses both. Mackinder states, “The oversetting of the balance of power in favor of the pivot state, resulting in its expansion over the marginal lands of Euro-Asia, would permit of the use of vast continental resources for fleet-building, and the empire of the world would then be in sight. This might happen if Germany were to ally herself with Russia.”³³ Although the Heartland land LOC is critical, when combined with a sea LOC (territorial Germany) and technology (a modern Navy), Mackinder believes it could morph into World Empire.

Beyond the military and political power projection of the land LOCs, Mackinder has a deep understanding of what they mean to modern commerce. Where Mahan lays the foundation for a more global economy, Mackinder goes much further. Mahan views the sea-lanes as protected by the military for the purpose of global commerce. Mackinder interjects a richer view of the industrial capacity of a nation and its relationship to communications. LOCs of modern industrial nations do not stop at the port or the amphibious assault zone.³⁴

Since LOCs must travel into and out of a country, land LOCs offer considerable efficiency over sea LOCs. Mackinder notes that although the transportation costs of the sea are inexpensive, sea LOCs require

³² Mackinder, “The Geographical Pivot,” 434.

³³ Mackinder, “The Geographical Pivot,” 436.

³⁴ Julian Stafford Corbett, *Some Principles of Maritime Strategy*, Classics of Sea Power (Annapolis, Md.: Naval Institute Press, 1988), 100. Mackinder’s view is analogous to Corbett’s holistic view of maritime LOCs. Corbett states that when compared to land LOCs, “maritime communications have a wider meaning. Though in effect embracing the lines of fleet supply, they correspond in strategical values not to military lines of supply, but to those internal lines of communication by which the flow of national life is maintained ashore.”

four key handling times “the factory of origin, at the export wharf, at the import wharf, and at the inland warehouse for retail distribution.”³⁵ While land communications require only two transfer points—from factory to warehouse.³⁶ Beyond the simple amount of handling that commerce requires, Mackinder recognizes the need to integrate home manufacturing, transportation, and markets. He moves beyond Mahan’s overarching supply-chain theme and provides a practical example, through the railroad and the Heartland, of how it works. This is why the Heartland is so valuable—it not only has the flat region conducive to travel, but also the previously mentioned resources to develop a manufacturing economy.

Mackinder also integrates financial and political nuances into his view of commercial LOCs. Mackinder rejects Mahan’s broad support of global free trade, backed by vigilant naval power. According to Gerry Kearns, a modern biographer of Mackinder, Mackinder believed “free trade required access to markets and that this was only retrained by the threat of using force against rivals who would close access. Free trade thus rested upon taxation for the Navy...negotiation with commercial rivals meant having either tariff barriers to barter with, or ships to batter with.”³⁷ Free trade, rather than a panacea for Mackinder, actually limits state power in his geopolitical analysis. Mackinder stood athwart those of his own time who espoused free trade for Britain. In fact, Mackinder lost an election to the House of Commons to a free-trade liberal in 1909.³⁸

Looking back, Mackinder had historical basis for his reluctance to trumpet the free market as a solution for Great Britain. In his classic, *War and Change in World Politics*, Robert Gilpin argues that only recently have “superior economic competitiveness and superior military

³⁵ Mackinder, “The Geographical Pivot,” 434.

³⁶ Mackinder, “The Geographical Pivot,” 434.

³⁷ Kearns, *Geopolitics and Empire*, 57.

³⁸ Kearns, *Geopolitics and Empire*, 57-58.

power...tended to accompany one another. Great Britain and the United States have had an incentive to use their military power to create a competitive world market economy...Historically, in fact, as Montesquieu long ago observed, commercial powers in the pre-modern period usually became the prey of more aggressive military powers.”³⁹ Therefore, in Mackinder’s time, Britain was the first and only example of a world power to have combined free markets with world military power.⁴⁰ Given that Mackinder believed Britain itself was on the verge of decline as an island sea power, it is not surprising that he viewed free trade with suspicion. Mackinder went as far to theorize that the commercial elements of Great Britain should move to Canada to take advantage of its material resources and land LOCs.⁴¹ Thus, for Mackinder, economic competition is no less or more certain than the same competition that he sees between land and sea LOCs. Any attempt to harness an amoral integrated free-trade market for individual state gain seems foolhardy.

As a final *coup de grace* to the Mahanian sea power themes of his day—especially popular in Britain—Mackinder adroitly shows how recent sea power dominance by the Western powers since Columbus was atypical. The slow struggle around the Cape of Good Hope at the beginning of the age of discovery, finally gave “Europe influence round the Euro-Asiatic land-power [the Heartland] which had hitherto threatened her very existence.”⁴² In fact, in Mackinder’s historical journey, the threat from the Heartland actually drove Western Europe to

³⁹ Robert Gilpin, *War and Change in World Politics* (Cambridge ; New York: Cambridge University Press, 1981), 139.

⁴⁰ A.T.Mahan, *The Influence of Sea Power Upon History: 1660-1873* (Mineola: Dover Publishing: 1980), 52 and 68. Portugal and Holland might also serve as examples. However, the Portuguese based their economic and military power solely on resource extraction, which limited their ability to project power in the future. Holland also had a much more commercial than military culture. Mahan avers that Holland’s culture was “a commercial aristocracy, and made it averse to war, and to the expenditures which are necessary in preparing for war.”

⁴¹ Kearns, *Geopolitics and Empire*, 158.

⁴² Mackinder, “The Geographical Pivot,” 433. Mackinder, “The Geographical Pivot of History (Reprint of 1904 Article),” 433.

the sea.⁴³ As aforementioned, all the Heartland needed to threaten the sea power nations was a strong, insular, land-based-LOC economy, naval technology, and a German port.

The primacy of land LOCs permeates Mackinder's thinking. Under his closed-system view, the Second Law of Thermodynamics demands that a change in one area will have reverberations over the whole system. An exploited Heartland—with its large potential in economic benefit and internal isolation—represents the reverberation towards future world empire.

Mackinder and Technology

Mackinder veers sharply from Mahan's "atechnological" view of history toward a version of techonological determinisim. Mackinder places technology—which emanates from a nation's abilities in equivicance—with his main subject, geography. He states, "The importance of a given geographical feature varies with the degree of man's civilization. A city which depends on one physical advantage may fall at any moment. A single mechanical discovery may affect the change."⁴⁴ His technological fascination probably puts him under the category of what modern technology scholars call hard determinism. According to Leo Marx and Merritt Smith, from a hard deterministic view "agency (the power to effect change) is imputed to technology itself...thus the advance of technology leads to a situation of inescapable necessity."⁴⁵ Mackinder's hard deterministic view of technology dovetails with the Second Law of Thermodynamics that describes his closed system. As the change agenct, technology injects energy into Mackinder's world system.

⁴³ Kearns, *Geopolitics and Empire*, 152-153. Kearns, 158; *ibid.*, 152-153.

⁴⁴ Mackinder, "The Geographical Pivot," 152.

⁴⁵ Merritt Roe Smith and Leo Marx, "Introduction," in *Does Technology Drive History? : The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge, Mass.: MIT Press, 1994), xii.

Much like his historical analysis of the Asian steppes for mobility, Mackinder uses the European journey South to Cape Hope, and eventually to India, as a lesson in technology and geography. He details how the geography of the Sahara, with its strong countervailing east-to-west winds made sailing southward impossible until Columbus's time, "The clumsy coaster [small coasting ships of the time], incapable of sailing near the wind, could not venture southward on a current which would never veer to bring her home...the trade-wind and its deserts were the true southern boundary of medieval Europe."⁴⁶ Columbus, with improved navigation broke this trend.⁴⁷ The Portuguese in turn built better coastal exploration ships, called Carvels, improved navigational technology, and combined them into what John Law calls "a network of heterogeneous, but mutually sustaining elements."⁴⁸ In doing so the Portuguese, followed by the Dutch, and eventually the British, sailed to the Indies. Technologies in ship building and navigation were Mackinder's agent of change to overcome the daunting geographic challenge of sailing against the wind.⁴⁹

Although Mackinder views technology as important in any LOC context, the railroad is his technology *über-alles*. The railroad re-shapes the Heartland from a horse-ridden steppe, into Mackinder's world center. He avers, "Trans-continental railways are now transmuting the conditions of land-power, and nowhere can they have such effect as in the closed heart-land of Euro-Asia, in vast areas of which neither timber nor stone was available for road-making."⁵⁰ Since the railroad can be built from resources outside the Heartland, the need for a vast mileage of

⁴⁶ Halford J. Mackinder, *Britain and the British Seas*, (Oxford: Clarendon Press, 1907) Halford J. Mackinder, "Britain and the British Seas," (Oxford: Clarendon 1907). 9.

⁴⁷ Mackinder, "Britain and the British Seas," 9.

⁴⁸ John Law, "Technology and Heterogeneous Engineering: The Case of Portuguese Expansion," in *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, ed. Thomas P. Hughes Wiebe E. Bijker, and Trevor Pinch (Cambridge: MIT Press, 1987), 121.

⁴⁹ Mackinder, "On the Scope and Methods of Geography," 152.

⁵⁰ Mackinder, "The Geographical Pivot," 434.

roads with their prohibitive cost and continual up-keep is mitigated. The railroad allows the nation that owns the Heartland to bypass a technological step.⁵¹ By skipping such a technological step, in turn, the Heartland can more quickly industrialize.

Thus for Mackinder, the railroad forms the great technological link in a modern economy, connecting industrial output to consumers. While Mahan sees the ship as the most efficient means of transportation, Mackinder believes the railroad offers more overall efficiency to the modern industrial system. He states that in the past “Railways acted chiefly as feeders to ocean-going commerce” but now they could link food growing areas such as Odessa in the Heartland with manufacturing regions elsewhere, in a complex industrial supply chain consisting of resources, industry, and transportation.⁵² Railways also offer the potential to open up markets, which had only previously relied on sea trade.⁵³

The railroad provides the same technological linkage for military operations. The Russian movement of troops to Manchuria in 1904 greatly impressed Mackinder. During the mobilization, the Russians moved troops more than 6,000 miles to their border in short order.⁵⁴ Mackinder clearly has the German success of the late nineteenth century in using the railroad as applicable to Russia, and by extension the Heartland. ⁵⁵ He says, “In the world at large she [Russia] occupies the central strategical [*sic*] position held by Germany in Europe...The full

⁵¹ Mackinder, “The Geographical Pivot,” 434.

⁵² Mackinder, “The Geographical Pivot,” 434.

⁵³ Mackinder, “On the Scope and Methods of Geography,” 159. Mackinder mentions Bombay, India, which by the early 20th century had just begun rail service “carried over the mountains.”

⁵⁴ Mackinder, “The Geographical Pivot,” 434.

⁵⁵ Martin Van Creveld, *Command in War* (Cambridge, Mass.: Harvard University Press, 1985), 103-122. Van Creveld shows how Von Moltke used five railroad lines verse Austria’s one to win the campaign despite being three weeks behind the Austrian mobilization time table.

development of her modern railway mobility is merely a matter of time.”⁵⁶ After World War I, Mackinder would analyze the combination of the railroad, with the Germans’ state penchant for organization as both a threat to Britain and as a promise of how an efficient society could work in war.⁵⁷

Commerce comes to, industry flows out, and military power emanates from the Heartland on rail. The railroad is not just transportation medium in Mackinder’s view; it comprises the blood vessels of a modern industrial body. The Heartland cannot exist as the near peer competitor to sea power without the railroad. After World War I, in *Democratic Ideals and Reality*, Mackinder will add other technologies such as the airplane, the car, and the submarine, which also have potential to change LOCs.⁵⁸ Thus, Mackinder considers transportation technologies that can transcend or enhance geography as the source of energy for his world geopolitical system.

Mackinder for Today

Much like Mahan, if Mackinder still applies, then his theory holds some importance in a modern context. In both military and commercial realms, Mackinder has much to offer in terms of supply-chain management and the interaction between technology and LOCs. In many ways, his theory is much more predictive than that of Mahan.

In taking notice of how technologies interact within commercial and military transportation systems, Mackinder allows expansion of his theory into new technological discoveries. Whether in moving goods to market or troops to the front, Mackinder understands that less handling increases speed for commercial ventures and for military operations.⁵⁹

⁵⁶ Mackinder, “The Geographical Pivot,” 436.

⁵⁷ Mackinder, *Democratic Ideals*, 25. Mackinder considers the German state imbued with *Kultur* or the “ways and means” mind. He believed that Germans were poised to invade Russia (the Heartland) and that eventually the “blindly organizing state [goes] to its Armageddon.

⁵⁸ Mackinder, *Democratic Ideals*, 14

⁵⁹ Mackinder, “The Geographical Pivot,” 434.

While Mahan lays a foundation of future transportation concepts within supply-chain management, Mackinder fully embraces what mobility means to a modern manufacturing economy.

Mackinder builds his entire theory of global empire upon the historical mobility of the steppe.⁶⁰ Mackinder's view of mobility holds for both commercial and military aspects of transportation today. One recent Transportation textbook states, "The goods we consume, our economic livelihood, our mobility...are in some way affected by transportation."⁶¹ On the military side, United States Transportation Command is tasked to "Provide common-user and commercial air, land, and sea transportation, terminal management, and aerial refueling to support the global deployment, employment, sustainment, and redeployment of US forces."⁶² Conflating the commercial and military together, Mackinder is prescient in his understanding of the relationship of mobility, and thus LOCs, to world power.

Mackinder underscores the importance of technology to mobility, especially in its relationship to geography. He begins by transferring the historic geographical mobility of the steppes to a current technology, "Railways work the great wonders in the steppe, because they directly replace horse and camel mobility."⁶³ He also hints at future technologies in his description of British Sea Power dominance, "The revolution commenced by the great mariners of the Columbian generation endowed Christendom with the widest possible mobility of power, short of a winged mobility."⁶⁴ In *Democratic Ideals and Reality*, written two years after World War I, Mackinder would allow for the submarine, the

⁶⁰ Mackinder, "The Geographical Pivot," 432-433.

⁶¹ John Joseph Coyle, Edward J. Bardi, and Robert A. Novack, *Transportation*, 6th ed. (Mason, Ohio: Thomson/South-Western, 2006), 33.

⁶² United States Transportation Command, *2009 Annual Command Report*. 2.

⁶³ Mackinder, "The Geographical Pivot," 434.

⁶⁴ Mackinder, "The Geographical Pivot," 432.

automobile, and the airplane to become part of his mobility energy calculus.⁶⁵

Mahan Meets Mackinder

Is it meant, it may be asked, to attribute to sea power alone the greatness or wealth of any State? Certainly not...but it is the central link, which lays under contribution other nations for the benefit of the one holding it, and which, history seems to assert, most surely of all gathers to itself riches

A.T. Mahan

The oversetting of the balance of power in favor of the pivot state, resulting in its expansion over the marginal lands of Euro-Asia, would permit of the use of vast continental resources for fleet-building, and the empire of the world would then be in sight.

Halford J. Mackinder

After examining their basic tenets on LOCs and technology and extrapolating forward, how do Mahan and Mackinder compare to each other? Given the massive amount of logistics, which flowed on land and sea, during World War I, the conflict represents a testing ground for their theories. In addition, since the war happened relatively close to their writing, it provides a nice snapshot in time of how their ideas did or did not apply. The World War I major fronts—on the east and in the west—represent the two main areas, along with those operations in the periphery (i.e. the Middle East and Turkey) to illuminate the successes or failures of each theory. After World War I, the introduction of the airplane will add a new medium for LOCs, followed by a further testing ground in World War II.

Is command of the sea necessary and sufficient for military and economic power as Mahan posits? Alternatively, are the land-centric politics and the pace of technological change generating the geopolitical considerations Mackinder posits? Finally, are sea and land LOCs in competition or do they complement each other? In all of these analyses,

⁶⁵ Mackinder, *Democratic Ideals*, 14.

the interplay between the theory, LOCs, and technology will form the nexus of discussion.



Chapter 3

World War I: Rail, Wave, and the Spark of War

The great growling engine of change - technology

Alvin Toffler

During World War I, the battle between the Allies and the Central Powers would pit sea and land LOCs, and by extension, the theories of Mahan and Mackinder against each other. The war would also line up the proven technologies of steamships and railroads against each other and against newer technologies, such as the internal combustion engine (in the form of the supply truck and the airplane), the mine, and coastal artillery. LOCs and associated weapons technologies would characterize combat on the Western Front, the Atlantic Ocean, the Eastern Front, and other regions such as the Dardanelles and Palestine.

The war exacted a horrible price—10 million dead from combat and 5 million wounded.¹ World War I also signaled a great change in geopolitics with the loss of power for the Austro-Hungarian and Turkish Empires, the demise of three monarchies—the Habsburgs in Austria-Hungary, the Hohenzollerns in Germany, and Romanovs in Russia. While the Windsors in Britain managed to hang on, their empire was left on a path to the insolvency realized in the early stages of the next world war. France also suffered blows to her demography, finance, and psyche from which she would never recover. World War I left fertile ground for the Soviet experiment in Russia and the fascist regimes of Germany and Italy. It established the United States as a great power and Japan as an emergent challenger on the Pacific Rim. The interplay of sea and land lines of communication and their associated technologies underwrote the entire transformation of the geopolitical landscape.

¹ John Keegan, *The First World War*, 1st American ed. (New York: A. Knopf ; Distributed by Random House, 1999), 1,6.

Ultimately, Mahan's command of the sea underpinned the Allied victory, through starvation of the German population and delivery of the American forces. However, Mackinder's railroad, with its influence on land LOCs, nearly carried the day for the Central Powers. Germany owned a large portion of the heartland before 1918, but was unable to convert the resources of the region into war supplies quickly enough to counteract the influx of American resources into the western theater.

The Technical Landscape of Propulsion and Logistics

I shed many a tear when the steam engines went out of style...I'd like to see them come back, but I realize the diesels are more efficient.

Clyde Tombaugh

The world Mahan described in 1890 and Mackinder portrayed in 1904 did not stand still. The steam engine, which replaced Mahan's three-hundred-year-dominant sailing ship in under fifty years, was being slowly eclipsed. On the land, the internal combustion engine, in the form of the truck, would slowly rise to more prominence during the First World War. However, the steam engine powering locomotives and rail cars would still be the dominant form of movement on the land. On the ocean, the internal combustion engine in the form of the diesel-engine-powered submarine would challenge British supremacy at sea. The airplane would begin to make inroads as an arbiter of LOCs for both land and sea. The internal combustion engine moved from a novelty at the beginning of the war, to a requirement of modern industrial warfare by 1918.

In a steam engine, steam is the by-product of thermal inefficiency within the system—not its power—as often assumed. The metaphor for the engine actually describes its inefficiency. Due to the loss of energy through steam, the steam engine requires enough size to compensate for

the energy loss.² Therefore, steam works reasonably well in bigger engines, e.g. marine and rail engines.

By using flame, compression, and oil based liquids, the internal combustion could generate much more power than a steam engine with a smaller size. Designed by Étienne Lenoir and perfected by Nikolaus Otto, the internal combustion engine, would get its spark from the conflagration of World War I.³ The internal combustion engine would eventually change how nations viewed LOCs and thus geopolitics.

World War I was the initial test of the submarine and the airplane in war. In addition, it was the first mass use of railroads and modern ships in sustained industrial war. Table 1 below shows representative technologies and their capabilities at the start of the war. By the time World War 2 begins thirty years later, these technologies will evolve exponentially in size, speed, range, and firepower.

² Eric Dorn Brose, *A History of the Great War : World War One and the International Crisis of the Early Twentieth Century* (New York: Oxford University Press, 2010), 292.

³ Charles Fayette Taylor, *The Internal-Combustion Engine in Theory and Practice*, 2nd ed., 2 vols., vol. 2 (Cambridge, Mass.: M.I.T. Press, 1985), 352. Taylor explains that since the invention of Otto's, "silent engine about 1876 and the Diesel engine about 1897," there has been relatively little change in these two critical engine designs.

1914 Representative Technology	Power Source	Length	Speed	Range	Kinetic Reach
German Submarines	Internal Combustion	210 Ft	15/8 knots	5300 NM	400 yards
Airplane	Internal Combustion	21 Ft	57 knots	10,000' Ceiling	Unproven
Dreadnought	Steam	530 Ft	21 knots	6200 NM	9.7 NM
Railroad	Steam	Varies	17-34 knots	N/A	N/A

Table 1: 1914 Representative Technologies

Sources: Bernard Fitzsimons, The Illustrated Encyclopedia of 20th Century Weapons and Warfare; Phillips Payson O'Brien, Technology and Naval Combat in the Twentieth Century and Beyond; Edwin A. Pratt, The Rise of Rail-Power in War and Conquest, 1833-1914, with a Bibliography; Wikipedia.

Through Mahanian and Mackinderite lenses, the LOC technologies of World War I, both support and refute their arguments. From Mahan's view, command of the sea and maintenance of LOCs was still the determining factor in the Allies' success. While at the same time, command of the sea took on a completely different character than Mahan imagined due to mine, submarine, airplane, coastal artillery, and other modern industrial technologies.

Instead of Mahanian ship-of-the-line battles for decisive command of the sea, the British used far blockades to hold the German fleet at bay while protecting their own ships from mines. Rather than defend key geographic points and Mahan's commons for the flow of commerce, British surface fleets deployed in convoys to protect war supplies, commerce, and troop ships from submarines. As part of this process, aircraft would perform critical intelligence, surveillance, and

reconnaissance missions to locate submarines. The back and forth between the German and British Navy followed the much more fleeting sea control as espoused by the British theorist Julian Corbett.

At the strategic level, Mahan's command of the sea was necessary, but no longer sufficient for wartime logistics and commerce. Once ashore the sheer amount of supplies to the front required the Allies to build railroads from ports to the trenches.⁴ This, in modern industrial war, a nation required more than Mahan's amphibious operations. Without the ability to manufacture, deploy, and maintain Land LOC technologies, such as railroads, a nation could not project power.

From a Mackinderite view, the railroad proved invaluable for deployment, strategic set piece battles, and static front lines on all fronts. On the Eastern Front, with a large expanse, low density LOCs and primitive seasonal roads, trains provided the primary means of significant advance or retreat for the Central Powers and the Russia. During mobile operations on the Western Front, however, the railroad lagged behind, and Armies marched to battle as they had done a century earlier.

Mackinder's analysis of the heartland was prescient in terms of geopolitics. The German impulse to gain the heartland with the declaration of war against Russia in August 1914 did unite the Allies as Mackinder predicted.⁵ However, his belief that the combination of the heartland with German sea access would circumscribe the sea powers of Britain and the United States was inconclusive.

The Germans controlled Mackinder's united German-heartland region after the treaty of Brest-Litovsk in December 1917. However, they lacked the time necessary take material advantage of the region.

⁴ John Keegan, *An Illustrated History of the First World War*, 1st ed. (New York: A.A. Knopf, 2001), 162. During World War I, "all armies found it convenient to run light railways from the main lines up to the front. They were more easily repaired when damaged by shell-fire than roads."

⁵ Halford J. Mackinder, "The Geographical Pivot of History (Reprint of 1904 article)," *The Geographical Journal* 170, no. 4,, 2004, 436.

The successful Allied victory in the First Battle of the Atlantic, gave the Allies uninterrupted supply to the Western Front and the ability to deliver significant American troops to bear during the critical Ludendorff Offensives during the spring of 1918. Thus, rather than a German-heartland circumscribing Britain and the United States, the uniting of the Allies in opposition to German control of the heartland, presaged German defeat. Because of sea control, the Allies starved the Germans, while bringing fresh US troops to bear during the critical Ludendorff Offensives during the spring of 1918.⁶ However, Mackinder's analysis does leave room for technological development. Thus, the use of mines or the internal combustion engine does not upset his theoretical understanding under which "a single mechanical discovery may affect the change."⁷

Prelude to Railageddon: The German Wars of Unification

Germany's Schlieffen Plan, developed for the invasion of France, was no mere paper exercise. Schlieffen built his vision on Helmut Von Moltke the elder's theories of Army command and control coupled with operational logistics experience from the Königgrätz campaign of 1866 and the Franco-Prussian war in 1870.⁸ Although Schlieffen would retire in 1906, his plan formed the cloth from which the German staff under Von Moltke the younger would robe their 1914 invasion of France.

The Schlieffen plan called for right, center, and left wings. Three armies would attack from the north as part of the far right wing and

⁶ Brose, *A History of the Great War*, 227. This is not to say that the German people revolted against the German high command. Despite the estimated 730,000 casualties due to the blockade, the population never rioted on any large level. However, the German leadership and the nation were war-weary and with the influx of American troops in the summer of 1918, the German Army could not stem the tide. Such resilience on the part of the German population would lead to the mythical "stab in the back" which Hitler promulgated in the 1930s. The "stab in the back" was the belief that the German High Command had given up on the war, while the people had suffered and were willing to endure more.

⁷ Mackinder, "On the Scope and Methods of Geography," *Proceedings of the Royal Geographical Society and Monthly Record of Geography*, vol. 9. no. 9, 1897, 152.

⁸ Martin Van Creveld, *Command in War* (Cambridge, MA: Harvard University Press, 1985), 103.

attempt to envelop Paris. Two additional armies would attack through Luxembourg on the center wing, while two others would hold the South as part of the left wing (See Figure 6 Below).⁹ The plan called for the capture of Paris and the surrender of France in six weeks. In order to reach such an audacious goal the Germans committed 730,000.¹⁰



Figure 6: The Schlieffen Plan

Source: Webmatters.net, WWI Maps

The aggressive timeline, large manpower requirement, and long distances the far right wing would travel, necessitated fast moving LOCs

⁹ James B. Agnew and others, "Atlas for the Great War," in *The West Point military history series* (Garden City Park, NY: Square One Publishers, 2003), 3.

¹⁰ Keegan, *An Illustrated History of the First World War*, 68.

with large throughput. As Mackinder predicted, it was the railroad that offered the Germans the mobility and capacity they needed, "In the world at large she [the Heartland] occupies the central strategical position held by Germany in Europe." Germany can strike on all sides and be struck from all sides, save the north. The full development of her modern railway mobility is merely a matter of time."¹¹

World War I was not the first use of the Railroads for war by the Germans. During both the Königgrätz campaign against Austria (1866) and the Franco-Prussian war (1870-71), the Prussians relied heavily on the railroad. Von Moltke noted at that time, "Modern Wars will be carried on with armies of such strength that their provisioning can be accomplished only by means of railroads."¹²

Beyond espousing the necessity of railroads, the Germans learned that mating the technology of rail to army LOCs required foresight because "it was entirely wrong to assume that one could effect the concentration on the railroads with order and precision without very thorough and extensive advance preparations."¹³ As the Königgrätz campaign began, the Prussians quickly realized the railroads could not deliver the army to the desired point of "Gorlitz or Upper Silesia" with any speed.¹⁴ Therefore, the Prussians split their forces along a two-hundred-mile front, using five rail lines that stopped at the Austrian border, in hopes they could both supply from the trains forward and reunite the armies later.¹⁵

Although the Prussians admirably deployed their forces by rail, once the campaign started, railroads performed abysmally as purveyors of war equipment. The trains brought supplies forward, but getting them distributed beyond the railhead proved unsolvable for the

¹¹ Mackinder, "The Geographical Pivot," 436.

¹² Helmuth Moltke and Daniel J. Hughes, *Moltke on the Art of War : Selected Writings* (Novato, CA: Presidio Press, 1993), 102.

¹³ Moltke and Hughes, *Moltke on the Art of War*, 72.

¹⁴ Moltke and Hughes, *Moltke on the Art of War*, 96-97.

¹⁵ Van Creveld, *Command in War*, 106.

Prussians. As a result, more than 17,900 tons of supplies never made it to the front.¹⁶ As Martin Van Creveld notes in *Supplying War* “While bread went stale, fodder rotted and cattle died of malnutrition, field commanders were at least free to ignore the effects of logistics on operations because, as the troops had completely outrun their supply convoys, all connection between them and the railways was lost.”¹⁷

During the Franco-Prussian war, the lessons of Königgrätz were not lost on Moltke. In fact, he had planned and trained forces called, *Eisenbahntruppe* (railway troop), beginning in 1859. With this foresight and the lessons of Königgrätz, the Prussians had 200 railroad specialists designed to build and repair track under wartime conditions by 1870.¹⁸

As the Franco-Prussian war, began the railroads again served the Prussians well during the mobilization phase. However, after the armies reached the front, the railroads fell rapidly behind. The same crowding, lost supplies, and inefficient delivery reoccurred. When the Prussians reached Paris in October 1870, the supply trains had only just broken through a backlog at the French Fortress of Metz.¹⁹

The French had also learned from the Prussians’ success at Königgrätz. During the Franco-German War, the French system of trains formed an internal LOC and the French Army more centrally controlled their rail system than the more commercially oriented lines of the Prussians. The French also destroyed lines as they treated and harassed German railways behind their front. Despite this advantage, the French suffered from backlogged trains and inadequate communication with the front, just as the Germans had.

In sum, trains were critical to the Prussian and French mobilization phases in 1870. However, once the mobile phase started,

¹⁶ Martin Van Creveld, *Supplying War: Logistics from Wallenstein to Patton* (Cambridge ; New York: Cambridge University Press, 1977), 84.

¹⁷ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 84.

¹⁸ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 105.

¹⁹ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 100.

both armies marched and ate in the same manner Napoleon had half a century earlier. Although the railroad may not have been the smashing success that Moltke promulgates in his autobiography, the railroad's ability to deliver masses of troops to a designated space in a short time had changed the character of land warfare forever.

Moltke the Younger and Schlieffen 2.0

As the Germans prepared for World War I, Moltke the younger further refined Schlieffen's plan. Schlieffen mandated the right wing march through the Netherlands then down to envelop Belgium and Paris; "the last grenadier on the right wing should brush the Channel with his sleeve." In doing so Schlieffen had hoped to capture the entire Belgium Army and halt any British Forces from arriving by sea²⁰. However, by 1914 this became diplomatically untenable.²¹ Moltke the younger then truncated Schlieffen's right wing to march through the Maastricht salient, avoid the Netherlands, and drive through Belgium to Paris.

However, this truncation meant more personnel and supplies moving on fewer railroads.²² Schlieffen designed his plan around the railroads. By forcing the right wing through the Netherlands, the plan allowed the army to take advantage of five major rail lines, rather than just two through Belgium. Schlieffen understood that he needed as many lines as possible to deliver the men and equipment necessary for the push to Paris. Anything less would likely backlog the rail lines as had happened in the wars with Austria and France.

Moltke compensated for his railroad limitations in the plan by preparing his force to take advantage of the new technology. The Germans now had more than 22,000 *Eisenbahntruppe* in 1914. The Germans also understood that they would be facing destroyed and

²⁰ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 115.

²¹ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 119-120.

²² Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 116-117.

sabotaged railroads beyond German territory. Moltke planned accordingly.

The Germans built up on elaborate system of rail technologies designed to construct railroads in foreign territory. One American observer remarked in February 1914 after his visit to Cologne:

Never, I believe, did a country so thoroughly get ready for war. I saw the oddest spectacle, the building of a railway behind a battle-field. They had diminutive little engines and rails in sections, so that they could be bolted together, and even bridges that could be put across ravines in a twinkling. Flat cars that could be carried by hand and dropped on the rails, great strings of them. Up to the nearest point of battle came, on the regular railway, this small one. ... It seemed to me that hundreds of men had been trained for this task, for in but a few minutes that small portable train was buzzing backward and forward on its own small portable rails, distributing food and supplies. . . . I've an idea that in time of battle it would be possible for those sturdy little trains to shift troops to critical or endangered points at the rate of perhaps twenty miles an hour...A portable railway for a battle-field struck me as coming about as close to making war by machinery as any-thing I have ever heard of. ²³

The Germans also increased their internal rail lines to both the west and the east. Along with new lines, they also built perpendicular tracks to transfer trains from one line to the next. As a result, the Germans had nineteen points crossing the Rhine and sixteen rail lines leading east, when compared to just nine in 1870.²⁴

The Western Front Begins: 1914

When World War I started in August 1914, the railroads once again performed brilliantly in mobilization. The Germans quickly delivered more than 1 million troops to the front and stormed into France and Belgium, fifteen days from the mobilization order.²⁵ However, within days the rail lines lagged far behind the infantry. By the first week of September, the German 1st through 4th Armies were

²³ Pratt, *The Rise of Rail Power in War and Conquest*, 236.

²⁴ Pratt, *The Rise of Rail Power in War and Conquest*, 288.

²⁵ Norman Stone, *The Eastern Front, 1914-1917* (New York: Scribner, 1975), 41.

60, 105, 60, and 40 miles, respectively beyond their closest established railhead.²⁶ Unfortunately for the Germans, these distances increased “at the very time when the opening of the battle of the Marne drastically increased the consumption of ammunition.”²⁷ At the same time, the French enjoyed short LOCs as the Germans threatened Paris. As the pace slowed, the French quickly shifted troops from their eastern lines back to Paris to defend the Marne.²⁸

Beyond the speed of their own infantry, the 22,000 strong *Eisenbahntruppe* had to overcome the Belgian and French rail systems. Although the gauges were the same, the French and the Belgians destroyed more tracks the further the Germans advanced.²⁹ In the case of Belgium, the Germans were lucky because Belgium failed to destroy the closest railheads to Germany.³⁰ In an ironic twist, the Belgians actually worked with the Germans in the decade preceding the war to ensure their rail lines interconnected. Ostensibly completed under peaceful commerce purposes, these efforts sealed the Belgians’ fate.³¹

Just as in Austrian campaign of 1866 and the Franco-German War four years later, railroads played little role as armies were on the move. For the Germans, cargo was misrouted and undelivered. In one example, the German Second and Third Armies received only six trains’ worth of supplies a day by August 31, 1914.³² On the other side, French railroads inadequately supplied armies in the field, until the Germans slowed. Once the battle of the Marne was obvious, the French were able to bring units from the east to bear.³³

²⁶ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 130-134.

²⁷ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 132.

²⁸ Keegan, *The First World War*, 111-112.

²⁹ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 129.

³⁰ Pratt, *The Rise of Rail Power in War and Conquest*, 293.

³¹ Pratt, *The Rise of Rail Power in War and Conquest*, 291-293.

³² Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 132-133.

³³ Keegan, *The First World War*, 111-112.

In both the French and German cases, the lack of rail support during mobile phases was filled by a new technology—the internal combustion engine. The engine helped power the trucks that supplied German troops on the move, while at the same time provided the “Taxis on the Marne” which reinforced the Parisian defenses with 6,000 troops.³⁴

Despite its setbacks as a mobile asset on the Western Front, rail was critical to both sides during the remainder of the war. Most of the large offensives, from the Somme to Verdun, involved large movements by rail to attempt to concentrate forces in space and time. In fact, trenches served less as defensive positions and more as screens for larger offensive movement. For the Allies and the Central Powers, trains allowed them to supply their well-dug-in troops in areas that roads could not traverse.³⁵

Mackinder West to the Marne and the Trenches

Mackinder put the railroad at the center of his theory. The railroad allowed a nation, especially one located as a primary land power, to match the speed and deployment capabilities of the ship. In the case of initial German operations on the Western Front, the railroad gave the nation the power projection necessary to get to Paris. The 42-day plan adapted by Von Moltke from Schlieffen demanded long and fast-moving LOCs, especially for the German First Army, which had to surround Paris. Even if the German Army had to live off the land as it reached the Marne in 1914, it ranged so far in part due to the trains massing nearly a million troops on the French border in under two weeks.³⁶

The ability to deliver such a mass of troops to the border changed how Germany dealt with its neighbors. In a positive sense, the Germans

³⁴ Michael Duffy, "TAxis of the Marne, 1914"
<http://www.firstworldwar.com/video/tAxisofthemarne.htm> (accessed 19 March 2012).

³⁵ Keegan, *The First World War: An Illustrated History*, 162.

³⁶ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 139.

were able to gain concessions from the Belgians on rail interconnectivity.³⁷ From a negative sense, by their obvious power projection to their eastern and western fronts, the nation precipitated a security dilemma for all of Europe. Although the causes of World War I are still debated, a modern rail system, coupled with the recent memories of the Wars of German Unification, did not encourage Germany's neighbors.³⁸ As a result, when Germany did invade in 1914, they faced a large and ready French Army.

Mackinder understood the power of technology to both project power and create security dilemmas: "Trans-continental railways are now transmuting the conditions of land-power."³⁹ The railroad might have given heartland nations much-needed mobility, but not without challenges from other nations. Any attempt at consolidation of power within the heartland would, "throw France into alliance with the over-sea powers, and France, Italy, Egypt, India, and Corea [sic] would become so many bridge heads where the outside navies would support armies to compel the pivot Allies to deploy land forces and prevent them from concentrating their whole strength on fleets."⁴⁰ Although Mackinder's theory was based upon Russia uniting with Germany to provoke such a response, German railroads crisscrossing Central and Eastern Europe represented the same threat. When Germany declared war on Russia and France in 1914, Mackinder's prediction came true.⁴¹

While understanding the geopolitical implications of railroads, Mackinder underestimates the difficulties of using rails in war. A popular myth holds that the German military was so prepared for both

³⁷ Pratt, *The Rise of Rail Power in War and Conquest*, 292.

³⁸ Brose, *A History of the Great War*, 40-41. Brose states technological change "heightened the fears and anxieties of nations like Britain and France, former industrial leaders surpassed by Germany in many critical, military related sectors."

³⁹ Mackinder, "The Geographical Pivot," 434.

⁴⁰ Mackinder, "The Geographical Pivot," 436.

⁴¹ Annemarie Sammartino, *The Impossible Border : Germany and the East, 1914-1922* (Ithaca, N.Y.: Cornell University Press, 2010), 18.

the Franco-German war and the events of 1914 that all the high command had to do was issue the order.⁴² However, as previously shown, the German general staff, under Moltke the Elder, Schlieffen, and Moltke the Younger spent fifty years integrating the railroads into their larger strategies for war. In addition, the operational and tactical employment of railroads in hostile territory proved insurmountable even for the 22,000 strong German rail forces.

Mackinder's view of the railroad also oversimplifies the advantages of rail in a supply chain. He states, "In the matter of commerce it must not be forgotten that ocean-going traffic, however relatively cheap, usually involves the fourfold handling of goods—at the factory of origin, at the export wharf, at the import wharf, and at the inland warehouse for retail distribution; whereas the continental railway truck may run direct from the exporting factory into the importing warehouse."⁴³ The German experience with railroads from mid-century to 1914 refutes Mackinder's simplicity.

Despite Mackinder's reduction of the railroad's true complexities, he does aver that the railroad has limitations—especially when used as a single LOC. He states, "The Trans-Siberian railway is still a single and precarious line of communication, but the century will not be old before all Asia is covered with railways." Therefore, without a fully integrated system, one rail line is too vulnerable to failure.

In Mackinder's defense, the Western Front was not the perfect test of his theory. Mackinder talks about railroads in relation to the steppes and the heartland rather than Western Europe. Moving trains through the somewhat mountainous regions of Western Europe was not consonant with Mackinder's vision. The Eastern Front, discussed later in this chapter, will prove Mackinder more prescient.

⁴²Pratt, *The Rise of Rail Power in War and Conquest*, 110.

⁴³ Mackinder, "The Geographical Pivot," 434.

Overall, the railroad was neither the guarantor of success that Moltke claimed in the 19th century, nor the lynchpin of automated war for his nephew in 1914, nor Mackinder's perfected land transportation vehicle. The railroads were quickly able to mobilize men on internal LOCs and deliver them to specific places. Supplies, however, were usually several miles behind the soldiers. Nonetheless, in the initial stages of World War I, rail favored the Germans.

The railroad deposited such massive amounts of troops in such a short amount of time, that even though they marched mostly on foot, it took the Allies more than three months to halt the Germans. At the same time, as the German offensive ground down, in part due to the failure of their rail system to move further into contested territory, the French were able to use rail to shift their troops quickly to defend Paris. It seems rail gave the advantage to the offense when it came to choosing the location of battle. However, using rail for lightning-quick land operations was untenable. In other words, rail aided the strategic offensive by affording mobility and concentration of forces; but it demonstrated severe limitations in aiding the offensive at the operational level, particularly in a war of movement where the defender had an established transportation network. The internal combustion engine, just a small player at this stage, would dramatically alter the transportation network in war thirty years later.

Back to Schlieffen Then to the Sea

The road and rail network surrounding Paris allowed the French to hold the Germans at the Battle of the Marne. The British Expeditionary Force (BEF) helped them in large part. The BEF was able to land at Boulogne on 14 August 1914 and march into Belgium to defend the Allies' left flank.⁴⁴ The original intent of the Schlieffen plan, the more northward movement through the Netherlands, was to head off

⁴⁴ Keegan, *The First World War*, 77.

any British landing on the continent.⁴⁵ When Moltke the younger redesigned the plan to go through Belgium, British landing capability was assured. In a twist of fate, Mackinder's great rail power had given Mahan's great sea power room to operate. As a result, the BEF helped the Belgians and French prevent the capture of Paris.

After the Battle of the Marne, each side would "race to the sea" in an attempt to outflank the other, ending with the First Battle of the Ypres salient in November 1914.⁴⁶ The railroads were critical for both sides in this race. Following the now similar pattern of set piece battles, the Allies using the Nancy-Paris-Arras rail line, the Germans using the Metz-Lille line, met in a "series of stalemated collisions" between the two railways.⁴⁷

Both sides then trenched the Western Front, the Germans in more defensive, permanent tranches, the Allies in more offensively minded trenches troweled into the mud.⁴⁸ Once the Western Front trench line was established, Mahan's sea LOCs (the Allies) and Mackinder's land LOCs (the Central Powers) faced off. With the Germans firmly ensconced in the industrial region of France, key for the Allies was the ability to supply her with sea LOCs that ran across the Atlantic and then the English Channel.

World War I: The First Battle of the Atlantic

Under Mahan's theory, command of the sea, gained and maintained by ships of the line, would enable commercial markets and fuel military power. According to Mackinder, rail could unite an autarkic land power in industrial and military might. With Allied victory, Mahan's theory would best Mackinder but not in the form Mahan predicted. Mahan may have predicted the outcome of the war, but its conduct was considerably different from his prescription.

⁴⁵ Van Creveld, *Supplying War: Logistics from Wallenstein to Patton*, 115.

⁴⁶ Keegan, *The First World War*, 127-131.

⁴⁷ Keegan, *The First World War: An Illustrated History*, 164.

⁴⁸ Keegan, *The First World War*, 122-123, 178-179.

The British maintained their century-long domination of the seas at the start of the war. The quick emplacement of the BEF into France took place without any attempt on the part of the German Navy to intercede.⁴⁹ For nearly two years, there were only minor skirmishes between ships of both sides, with nothing bigger than a cruiser engaged.⁵⁰ The vaunted Dreadnoughts, whose construction was one of the many causes of the war, had only one major battle, Jutland in 1916. The British, with a tactical tie but strategic victory at Jutland, maintained the preeminence of their large fleet by keeping the German surface fleet bottled up in port.⁵¹ Britain's superior geography, with open seas to her west, and her blocking abilities along the English Channel and the North Sea greatly helped keep the German Navy pinned down. The overall command of the sea remained with the Allies, but not without a fight from the technologically enhanced German Navy.⁵²

The lack of major naval engagements was attributable to two technologies: the mine and the submarine. Early in the war, the mine altered the British internal perceptions of sea dominance. In October 1914, a German mine sunk a brand new dreadnought—the HMS *Audacious*. According to John Keegan in *The First World War*, this “caused the British Admiralty even greater anguish than the torpedoing of the ancient cruisers *Aboukir*, *Hogue*, and *Cressy* by U-9 in the ‘Broad Fourteens’ off Holland in September.”⁵³

For the British, the Dreadnoughts were an important part of naval force-balancing vis-à-vis the Germans. Any sinking of a British capital ship redrew the strategic calculus. By the fall of 1915, the sinking of the

⁴⁹ Brose, *A History of the Great War*, 95. According to Brose, the Germany General Staff did not order the Navy to intercept the BEF troop movements because they assumed the German Army would sweep away the British and Belgians on land.

⁵⁰ Brose, *A History of the Great War*, 14.

⁵¹ Colin S. Gray, *The Leverage of Sea Power : The Strategic Advantage of Navies in War* (New York: Free Press, 1992), 178.

⁵² Keegan, *The First World War*, 215.

⁵³ Keegan, *The First World War*, 265.

HMS *Audacious* plus other British losses in skirmishes reduced British superiority in capital ships from 20:13 to 17:15.⁵⁴ Fear of mine-laden waters contributed partially to Jellicoe's much maligned hesitancy at the Battle of Jutland.⁵⁵

Far from passively accepting the mine as only a *guerre de course* tactic, the British turned the technology back on the Germans. As Germany progressed in its submarine usage over the course of the war, the British continued to mine the escape passages from the North Sea to the Atlantic. By the end of the war, only a very narrow corridor would be open between Norway and the British Isles.

The Unseen Enemy

...of all the tasks ever set to a Navy none could have appeared more baffling than that of sheltering this enormous traffic and groping deep below the surface of the sea for a deadly elusive foe.

Winston Churchill

Mine-laden waters off the German coast required the British Navy to patrol further from shore.⁵⁶ This in turn led the British to restrict shipping on a more complete basis, since they could not reliably choke off a port completely at the destination.⁵⁷ The inability of the German fleet to threaten the British fleet during the first years of the war led the Germans to introduce modern submarines to the fight. With their fleet stuck in port, the Germans could only disrupt commerce through a submarine campaign against Allied shipping.

While the internal combustion engine only supplemented steam rail operations during early World War I land operations, it provided parity with steam on the ocean. Suddenly a nation not known for its

⁵⁴ Keegan, *The First World War*, 215.

⁵⁵ Gray, *The Leverage of Sea Power*, 178.

⁵⁶ Gray, *The Leverage of Sea Power*, 11.

⁵⁷ Brose, *A History of the Great War*, 113.

ocean-faring prowess suddenly held the four-centuries-dominant British Navy at bay with diesel-powered submarines.

The Germans sunk 300 ships from February to June 1915, sending 800,000 tons to the ocean floor.⁵⁸ The stealthy nature of submarines led to international condemnation of German naval practices.⁵⁹ The U-boat sinking of the *Lusitania* in May 1915, which nearly forced the Americans to break off diplomatic relations with Germany, caused the Germans to scale down the practice of sinking unarmed shipping vessels.⁶⁰

By 1917, the German high command worried less about the Americans and more about their own survival. The British naval blockade had diminished the average German caloric intake to just thirty percent of pre-1914 levels.⁶¹ On wartime footing, the German leadership supported the Army with wheat and potatoes; as a result, the home front rationed most of its food. A poor 1916 harvest diminished most of the wheat and potato crop. Protein was non-existent.⁶² As a result, the German population had to eat turnips and rutabagas from 1916 until the end of the war.⁶³

In attempt to break the blockade, the German Navy engaged the British in the only major ship-of-the-line battle of the war at Jutland on 31 May 1916. The neutral outcome of the battle gained the Germans little. As the war continued into 1917, the German High Command returned to unrestricted submarine warfare to break the sea blockade. The Germans turned their submarines loose in the Atlantic, sinking a total of 4.2 million tons of US shipping alone from February 1917 to

⁵⁸ Brose, *A History of the Great War*, 113.

⁵⁹ Brose, *A History of the Great War*, 114.

⁶⁰ Keegan, *The First World War*, 265.

⁶¹ Brose, *A History of the Great War*, 227.

⁶² Keegan, *The First World War*, 318.

⁶³ Brose, *A History of the Great War*, 277.

October 1918.⁶⁴ While previous submarine campaigns netted less than 100,000 tons per month, the unrestricted campaign sunk over 830,000 tons in April 1917.⁶⁵

The effect of the unrestricted submarine warfare was two-fold. First, it unequivocally brought the Americans into the war on the side of the Allies.⁶⁶ Second, it forced the British to change their understanding of sea warfare and sea LOCs. Based on centuries of war at sea and as the world's commercial leader, British civilian and naval experts had established views of the integration between war and commerce. In order to keep the sea-lanes open, the British believed the Navy should engage and destroy ships of the line. In this way, the commons would be clear and commerce could proceed on its own. In January 1917, a month before the Germans resumed their submarine campaign, the British Navy's operations arm concluded, "it is evident that the larger the number of ships forming the convoy, the greater is the chance of a submarine being able to attack successfully."⁶⁷ In other words, commerce ships should sail by themselves.⁶⁸

Such operational tactics resulted in record numbers of Allied ships sent to the ocean floor in the early months of 1917. According to Michael Neiberg in *Warfare in World History*, "German U-boats were soon sinking one in four ships that left British ports."⁶⁹ When faced with these grim statistics, the Allies developed a new system of convoy escort for protection.

⁶⁴ Benjamin O. Fordham, "Revisionism Reconsidered: Exports and American Intervention in World War I author," *International Organization* 61, no. 2 (2007): 288.

⁶⁵ Gray, *The Leverage of Sea Power*, 198.

⁶⁶ Fordham, "Revisionism Reconsidered," 285. Fordham posits that America's interest was economically motivated. War commerce raised the share of exports to the Gross National Product to 12% before 1917—a level it would never reach again. Unrestricted submarine warfare represented a great threat to the American economy.

⁶⁷ John Terraine, *Business in Great Waters : The U-Boat Wars, 1916-1945* (London: L. Cooper, 1989), 52-53. As quoted in Keegan, *The First World War*, 354.

⁶⁸ Keegan, *The First World War*, 354.

⁶⁹ Michael S. Neiberg, *Warfare in World History*, Themes in World History (London ; New York: Routledge, 2001), 65.

Under the convoy system, warships would escort groups of merchant ships from port to port. With warships hovering around their prey, German submarines were reluctant to surface and fire on commercial ships for fear of being seen.⁷⁰ In addition, the Allies employed airplanes to help spot submarines. Aircraft increased the visual range the Allies could acquire submarines from five miles from the top of the tallest British destroyer, to more than 60 miles from an airplane flying at 3,000 feet.⁷¹ Thus, the Allies used one internal combustion engine technology to help defeat another. By the summer of 1918 successful German attacks on British shipping decreased from 25 to 4 percent.⁷²

Important for the outcome of the war, even more so than the German population's suffering, unrestricted submarine warfare greatly influenced the American decision to enter the war in the spring of 1917. The brilliantly planned Ludendorff offensives of 1918 nearly won the war for the Germans, but fresh American troops stemmed the tide.⁷³ When the Allies pushed the Germans back to their original trench lines in September 1918, war-weary Germany was finished. The American intervention was too much to bear.

Mahan Out to Sea

Mahan's basic premise concerning command of the sea held in the First Battle of the Atlantic. He states, "National and international functions can be discharged, certainly, only by command of the sea...The question is not 'naval,' in the restricted sense of the word. It is one of national policy, national security, and national obligation."⁷⁴ In addition, his belief in sea LOCs as purveyors of economic and military

⁷⁰ Neiberg, *Warfare in World History*, 65.

⁷¹ Abbatiello, *Anti-Submarine Warfare*, 32.

⁷² Neiberg, *Warfare in World History*, 65.

⁷³ Keegan, *The First World War*, 411.

⁷⁴ A. T. Mahan and John B. Hattendorf, *Mahan on Naval Strategy : Selections from the Writings of Rear Admiral Alfred Thayer Mahan*, Classics of Sea Power (Annapolis, Md.: Naval Institute Press, 1991), xx.

power held true. The Allies won, while the land-dominated Central Powers with their impressive transcontinental railroads starved suffered food shortages.

The Battle of Atlantic illustrates the positives and negatives of Mahan's theory. Mahan posited six key elements to sea power: Geographical Position, Physical Confirmation, Extent of Territory, Number of Population, Character of the People, and Character of the Government.⁷⁵

Since Mahan conceived of the elements with the British in mind, naturally Britain meets the characteristics of each. On the German side, a more interesting argument arises. In the first two categories, Germany lacks considerably when compared to Britain. Its coastline is small and British sea-lanes encircle Germany's route to the open Atlantic. Due to its geography, Mahan states that Germany "must remain a continental State, in immediate contact with powerful rivals. Historically, no nation hitherto has been able under such conditions to establish a supreme sea power."⁷⁶

Despite the limitations in geography, Germany challenged the British fervently in the North Atlantic, if only briefly, in 1917 with the unrestricted submarine campaign. The threat was so grave that Britain had to employ entirely new convoy procedures and aircraft technology to turn back the U-boat onslaught. In addition, the threat of the German Navy required constant vigilance and a complicated far blockade composed of sea-mines and hundreds of British ships.

How did a non-naval nation, in Mahan's view, strike fear into the heart of the greatest naval power in the history of the world? Mahan's last two categories, population and government, have some explanatory power. Mahan in his section on population *In the Influence of Sea Power*

⁷⁵ A.T. Mahan, *The Influence of Sea Power Upon History: 1660-1873* (Mineola: Dover, 1980), 28-29.

⁷⁶ Mahan and Hattendorf, *Mahan on Naval Strategy*, 340.

makes some overarching stereotypes of nations. For example, the British were a nation of risk-taking “shop keepers,” while the French sought wealth by “thrift, economy, hoarding,” and the Spanish and Portuguese drove for riches by “digging gold out of the ground.”⁷⁷ The characteristics of the British thus suit the nation better as an ideal commercial sea power. Due to his belief that the physical characteristics sealed the Germans’ fate as a minor sea power, Mahan neglects to include them in his analysis of population.

If Mahan’s analysis had included Germany, he might have looked at the nation’s ability to construct trans-continental railroads and their impressive integration of the telegraph into late 19th century military operations. In other words, if Mahan had looked at Germany’s population he may have seen a modern nation with a proven ability to apply modern technology to solve economic and military problems. However, Mahan’s ahistorical views on technology prevented him from seeing beyond natural geography and ships-of-the-line as naval destiny.

Mahan’s view of the government also can explain some of Germany’s naval success. Mahan avers, “More important even than the size of the navy is the question of its institutions, favoring a healthful spirit and activity, and providing for rapid development in time of war...”⁷⁸ Looking back to the Königgrätz and Franco-German campaigns, Mahan’s theory fits. Coupled with Germany’s growing industrial base and aggressive empire building in the late 19th Century, the nation was ready to become a rising sea power.

Missing from Mahan’s theory is any meaningful accounting of technology as a factor in naval supremacy. To be fair, in his period of analysis, 1660-1783, naval technology was for the most part static, and battle at sea was essentially symmetric. Ships fought others of like size or suffered according to the differential. Nonetheless, by the end of the

⁷⁷ Mahan, *The Influence of Sea Power*, 52-53.

⁷⁸ Mahan, *The Influence of Sea Power*, 88.

nineteenth century, when Mahan actually wrote, things had changed. The automotive fish torpedo virtually allowed a rowboat to dispatch a capital ship, and the submarine emerged as the ideal platform for its stealthy employment. Long-range coastal artillery, mines, and steam propulsion greatly complicated the business of blockade. Moreover, propagation of railroads in coastal areas cast considerable doubt on the efficacy of amphibious operations. Most importantly, a nation of engineers such as Germany might indeed assert itself at sea over a nation of shopkeepers. The construction of ships, velocity of guns, and systems of range finding, aiming, and fire control all became important factors in warfare at sea. For Mahan to ignore technology, including the impact of railways, constitutes gross theoretical negligence.

Nonetheless, parts of his theory have both explanatory and predictive power. *The Influence of Sea Power on History* asserts that command of the sea gains a nation five distinct advantages. First, the state can conduct commerce in a manner it sees fit. Second, it can deny other nations the same ability in commerce.⁷⁹ Third, command of the sea allows a nation to blockade enemy ports (as opposed to destroying commerce, which Mahan believes has only transient effects).⁸⁰ Fourth, command gives a nation the ability to bombard enemy coastlines.⁸¹ Finally, control of the sea allows for amphibious operations on land with speed and timing land forces cannot match.⁸²

For the most part, these five advantages read like a laundry list of Allied naval success during World War I. Most notably, in its relation to land communications was the British amphibious delivery of the BEF to

⁷⁹ Mahan, *The Influence of Sea Power*, 539-540.

⁸⁰ Mahan, *The Influence of Sea Power*, 87. Mahan worries that without a strong Navy, the US, will face enemy blockade and commercial ruin.

⁸¹ Mahan, *The Influence of Sea Power*, 296.

⁸² Mahan, *The Influence of Sea Power*, 296. Mahan describes the French bottling up of Cornwallis at Yorktown as an example of both amphibious operations (the fleet initially dropped off French troops to help the operation) and then blockage (the French prevented the British from escaping out to the Atlantic while simultaneously keeping the British out of the Chesapeake).

France in August 1914. It is doubtful the French could have held at the Marne or prevented the Germans from enveloping them in the race to the sea, without British support. Inserted from the sea, the British force held at the First Battle of Ypres, and provided just enough balance to lock the two sides into four years of trench warfare.⁸³

Beyond his overarching view of command of the sea and its subsequent benefits, Mahan also displays a prescient view of convoys.⁸⁴ Since Mahan's entire theory views command of the sea as the basis for economic and military power, protecting cargo and ship-borne troops is important. Mahan writes, "Protection localized with the convoy, that is, a body of armed ships in company...the forces of these armed ships was proportioned to the importance of the enterprise."⁸⁵ Thus, Mahan's theory rightly explains why and how the Allies protected shipping—especially with the increased German U-Boat threat of 1917.

Concerning the First Battle of the Atlantic, Mahan's theory offers explanation on the advantage that sea power provides a nation. Command of the sea and maintenance of sea LOCs were critical to Allied victory. However, *how* the Allies gained command of the sea did not fit Mahan's theory.

Mahan believes that ships-of-the line provide the means to command the sea, "This of course leads us straight back to the fundamental principles of all naval war, namely, that defence is insured only by offense, and that the one decisive objective of the offensive is the enemy's organized battle-fleet."⁸⁶ Put more directly, the essence of naval war is *guerre de main*. The nation that wins *guerre de main*, commands

⁸³ Keegan, *The First World War*, 124-125. Keegan has a map on these two pages illustrating Allied and German lines on the Western Front. The BEF held the more northern sections from the Somme to the North Sea.

⁸⁴ Neiberg, *Warfare in World History*, 65. One limitation of Mahan's analysis is his view of the transient nature of commerce destroying. The German U-boat campaign of 1917 sunk 25% of British shipping and required a wholesale change in tactics.

⁸⁵ Mahan and Hattendorf, *Mahan on Naval Strategy*, 185.

⁸⁶ Mahan and Hattendorf, *Mahan on Naval Strategy*, xxv.

the sea. In Mahanian terms, either a nation has command of the sea or it does not.

As the First Battle of the Atlantic showed, there were no binary choices in command of the sea. While the British controlled the North Sea and the English Channel, German U-Boats still managed to range free into the Atlantic Ocean. In addition, German mines kept the British from enforcing a close in blockade. Finally, the battle of Jutland proved indecisive, yet still allowed the British to maintain overall control of the North Sea, but at the same time allowed the Germans to escape to homeport as a fleet-in-being nuisance for the rest of the war. Thus, World War I seemed to show that command of the sea, *en toto*, was impossible. Sea control, much like its future sibling air superiority, had not only to be fought for and won, but also maintained.

Again, Mahan's atechnological view causes his theory to exhibit deficiencies under actual wartime conditions. Since he views "the submarine, as so far developed, possesses particular value only in the cases where the fleet to which it belongs is not exposed," Mahan cannot imagine a lone U-Boat sinking commercial ships and holding several British ships at bay.⁸⁷ In addition, while acknowledging the threat of the mine, especially after the Russo-Japanese War of 1905, he goes to great lengths to explain that mines can be overcome by the "skill and vigilance" of a large battle fleet.⁸⁸ Both the mine and the internal combustion engine, in the form of the submarine and the airplane, allow both sides to pursue the sea control they needed based on local circumstances. In World War I, universal command of the sea was fool's gold.

⁸⁷ Mahan and Hattendorf, *Mahan on Naval Strategy*, xxx.

⁸⁸ Mahan and Hattendorf, *Mahan on Naval Strategy*, 124.

Enter Corbett

*At that close range we won't last long against those
Star Destroyers!*

Admiral Ackbar, Star Wars Episode VI

Sir Julian Corbett, a British Naval Strategist, during the early 20th century, provides a counter-point to Mahan's theory. Mahan had garnered a large following in Britain after publishing *The Influence of Sea Power Upon History 1660-1783* in 1890. Partially in response to this popularity, Corbett looked at past British naval successes, most notably Trafalgar, a naval campaign missing from Mahan's analysis.

In doing so, Corbett does two things. First, he elevates naval strategy into a larger theory of war. He states, "Command of the sea, therefore means nothing but the control of maritime [lines of] communications, whether for commercial or military purpose. The object of naval warfare is the control of communication, and not as in land warfare, the conquest of territory."⁸⁹ Thus, sea communications can only be understood in terms of land power, much like Mackinder's view of the interplay between land and sea.

Second, he redefines the nature of command of the sea. Command at sea is fleeting, "one of the commonest sources of error in naval speculation...is the very general assumption that if one belligerent loses command of the sea it passes at once to the other belligerent."⁹⁰ In addition, the very nature of the sea prevents "us in locating him [the enemy] and determining his movements."⁹¹

When tested against the Battle of the Atlantic, Corbett's theory has much more explanatory ability than Mahan's does. Corbett's theory explains why the British had to win and maintain control of the sea. Even with their large force in the North Sea, the British could not

⁸⁹ Corbett, *Some Principles of Maritime Strategy*, 94.

⁹⁰ Corbett, *Some Principles of Maritime Strategy*, 91.

⁹¹ Corbett, *Some Principles of Maritime Strategy*, 159.

prevent U-boats from passing into the open ocean. In addition, in many localized instances, U-boats commanded their area of the sea. Although Corbett does not specifically address technology, he does not deny it either. Therefore, any changes in technology can change sea-LOCs, just as the mine and the internal combustion engine did. Command of the sea is impossible in Corbett's theory; in the same vein, it was impossible during the First Battle of the Atlantic.

Most importantly, Corbett places naval power in the context of land power. Without a capable land projection, naval power can do only so much. It was only in the service of a land LOC and commercial enterprise that a sea LOC had value. The landing of the BEF fits nicely into Mahan's theory, but its sustainment for inland operations is at the heart of Corbett's. For him the acid test of sea power was the performance of armies connected to the industrial home base through the sea communications. For Mackinder, it was the performance of armies supplied primarily by rail, and it is to them we now turn in the East.

East, West, and the Rails Twain

With the successful counter to the U-boat, the Allied blockade remained in place. The effects on the German economy and morale were devastating. Official estimates place German blockade-related civilian casualties at more than 730,000.⁹² Allied sea control enabled them to supply their own troops on the Western Front, while the German side had to ration their population to support their two-front war. While German soldiers had the better trenches on the Western front, usually on higher, drier ground, they lacked the plenty that surrounded Allied troops as they rotated back from the front.⁹³ In fact, German troops were aghast at the condition of their own populations during their home

⁹² Brose, *A History of the Great War*, 227.

⁹³ Keegan, *The First World War*, 408.

visits.⁹⁴ Despite the sacrifices on the home front, German morale remained high not because of the situation in the West, but because of victory in the East.

The movements in the East would personify Mackinder's Land LOCs and railroads. Both the Germans and Russians would use rail to move through the open spaces bypassing the primitive mud clogged roads of Mackinder's heartland.⁹⁵ For the Germans, the Western Front would loom large as they fought the Allied sea LOC, while holding their gains against the Russian LOC in the East. The extensive German rail network allowed the nation to shift troops hundreds of miles between fronts.⁹⁶ For the Russians, their poor command and control and internal political rife would prevent them from moving far into German territory. At the same time, the railroads allowed the Russians to escape east several times and shorten their own LOCs while extending the German Lines.⁹⁷ Only internal revolution would guarantee Russian defeat. This same pattern played out for Napoleon and would play out for Hitler two decades later.

The Eastern Front

This is the most comic war I have ever experienced...it is waged almost exclusively with trains and cars. One puts on the train a handful of infantrymen with machine guns and one gun, and one rushes to the next railway station. One seizes that station, arrests the Bolsheviks, entrains another detachment, and travels farther.

General Hoffman, Commander German Eastern Army

After initial Russian forays into Prussia in August 1914, the Germans quickly rebounded and won a stunning victory at Tannenberg

⁹⁴ Keegan, *The First World War*, 318.

⁹⁵ Mackinder, "The Geographical Pivot," 434. The roads are primitive through the Heartland—Mackinder hopes that the railroad can skip road building as a technological development.

⁹⁶ Stone, *The Eastern Front*, 67. Ludendorff received two army corps from the Western Front in September 1914.

⁹⁷ Stone, *The Eastern Front*, 183.

in late 1914. Then in the spring of 1915, the Germans broke out in a sweeping offensive to capture Warsaw.⁹⁸ After such a large victory, the German high command moved troops from the East back to the Western Front, a process that would repeat itself for the rest of the war. The Germans never committed enough forces to take the East, while the Russia faced serious internal political and military difficulties that prevented them from counter-attacking very far into German lines. The front between the Germans and Russians stalled until mid-1917.

Between 1915 and 1917, the Eastern Front would see Russian forays into Serbia and Central Powers moves on Romania. With the Bolshevik revolution in October 1917, the Germans used rail and sea to overtake Riga. The Russians proposed Armistice in December of 1917. As internal Russian politics muddled the peace process, German armies rode the rails confidently east, while the German Navy steamed into the Gulf of Finland.⁹⁹ By March of 1918, the Germans forced the Russians to sign the Treaty of Brest-Litovsk, which annexed the majority of the Ukraine, Estonia, Lithuania, and Latvia as part of the Second Reich.¹⁰⁰ This included more than “one thousand square miles of grain-rich Southern Russia” right in the middle of Mackinder’s beloved heartland.¹⁰¹ Thus, how the Germans achieved success in the East more resembled Mackinder’s vision than the land-sea stalemate on the Western Front.

The Eastern Front conjured up images for the Russians and Germans of past steppe conflict. The historic back-and-forth between East and West typified in Mackinder’s vision happened once again. “For a thousand years a series of horse-riding peoples emerged from Asia through the broad interval between the Ural mountains and the Caspian sea, rode through the open spaces of southern Russia, and struck home

⁹⁸ Keegan, *The First World War*, 231.

⁹⁹ Brose, *A History of the Great War*, 312.

¹⁰⁰ Brose, *A History of the Great War*, 313.

¹⁰¹ Brose, *A History of the Great War*, 314.

into Hungary in the very heart of the European peninsula, shaping by the necessity of opposing them the history of each of the great peoples around--the Russians, the Germans, the French, the Italians, and the Byzantine Greeks.”¹⁰² For the Germans, the Russian invasion of Prussian territory harkened back to “the Teutonic Knights who had won East Prussian from the heathen in the northern crusades.”¹⁰³ For the Russians, battle with the Germans represented another defensive stand against an army invading the steppes.¹⁰⁴ Despite their defensive past, however, the Russians had new technologies—the railroad and the internal combustion engine (the truck and the airplane)—which changed their traditional defensive posture into an offensive one.¹⁰⁵

In his classic work *The Eastern Front, 1914-1917*, Norman Stone chronicles how Russia remade itself after the humiliating defeat of the Russo-Japanese War. Far from being the backward, unready German foe, Russia turned economic growth into military preparedness. Russia’s “rolling-stock and railway mileage...was greater than Germany’s...By 1910, Russian mobilization could proceed at the rate of 250 trains per day; by 1914, 360; while by 1917 [the Russians] planned to have 560 trains rolling to the West every day.”¹⁰⁶ When turned towards East Prussia in August 1914, Russian “mobilization took thirty days for the 744 battalions and 621 cavalry squadrons involved, but was over for two-thirds of them by the eighteenth day...in 1917 [when the Germans began their advance on Riga], mobilization was to be completely over by the eighteenth day—only three days later than the termination of German mobilization in the west.”¹⁰⁷ Coupled with their

¹⁰² Mackinder, “The Geographical Pivot,” 427.

¹⁰³ Keegan, *The First World War*, 146.

¹⁰⁴ Stone, *The Eastern Front*, 33.

¹⁰⁵ Stone, *The Eastern Front*, 41.

¹⁰⁶ Stone, *The Eastern Front*, 41.

¹⁰⁷ Stone, *The Eastern Front*, 41.

extensive rail capability, the Russians also possessed an air force of “244 aircraft...the second largest in Europe.”¹⁰⁸

As had happened for the Germans on the Western Front, the Russian railroads performed brilliantly during the mobilization phase. By August 18, 1914, “63 infantry divisions were ready for action...The two [Russian] armies due to invade East Prussia were in fact ready before any of the others.”¹⁰⁹ Using their mobilization and personnel superiority—they had eight armies versus Germany’s one (at least in the initial phases)—the Russians quickly won the first Battle at Gumbinnen.¹¹⁰ German General Prittwitz was so unnerved, he withdrew his forces west over the Vistula River and shortly left the entirety of East Prussia under Russian control.¹¹¹ As a result, Moltke sent Hindenburg and Ludendorff east to take control of the front.

Shortly thereafter, the Germans under the direction of Prittwitz’s chief of staff General Hoffman, used railroads to move three corps to the South of the Russian left flank.¹¹² Notably, these forces were subtracted from Moltke’s right wing then closing on the Marne. More troops from the West were ‘stranded’ on trains traveling east to west and saw little action on either front. By design and treaty, the Russians had unhinged the German attack in the West. Nonetheless, the Germans won at Tannenberg, capturing 100,000 men and 400 guns. Norman Stone calls Tannenberg, “the most spectacular victory of the war” on any front, by any side.¹¹³

In one sense geography confounded the Russians, as the steppes of Asia retreated into the lakes and forest of East Prussia their movement was severely hampered.¹¹⁴ In addition, Russian leadership

¹⁰⁸ Keegan, *The First World War*, 144.

¹⁰⁹ Stone, *The Eastern Front*, 48.

¹¹⁰ Keegan, *The First World War*, 145.

¹¹¹ Brose, *A History of the Great War*, 69.

¹¹² Brose, *A History of the Great War*, 69.

¹¹³ Stone, *The Eastern Front*, 66..

¹¹⁴ Keegan, *The First World War*, 142.

lacked the foresight and a coherent organization to fight the battles demanded of them.¹¹⁵ Although they may have profited from the recent experience of the Russo-Japanese war, the Russians lacked a feel for the war of movement more typical of the German Wars of Unification. The latter, although two generations removed from the current corps of officers, seems to have left a strong impression on the German leaders. Thus, despite technological advantage (railways and aircraft), and numerical personnel superiority, the Russians could not take advantage.

Despite their defeat, the Russians regrouped and attacked back into Prussia and the Carpathian mountains in late 1914.¹¹⁶ The Germans then counterattacked in the spring of 1915, moving troops by rail to help their besieged ally in Hungary. The Gorlice-Tarnow breakthrough subsequently saw the Germans take great advantage of the Russian rail system, despite disparate gauge, and advance the front as far as 300 miles (See Figure 7).¹¹⁷ The Russians did not destroy the rail as effectively as the French and the Belgians had done a year prior. The retreat was so massive and uncoordinated that the Russians usually just kept pace with the attacking Germans. Norman Stone calls the 1915 retreat a “mad bacchanalia, while thousands of people trudge along the railway lines they are passed by speeding trains loaded with couches from officers clubs.”¹¹⁸ Only as the rail-lines, thinned seventy-five miles east of Warsaw did the German advance wane.¹¹⁹

¹¹⁵ Stone, *The Eastern Front*, 17-36. See Chapter 1 “The Army and the State in Tsarist Russia.” Stone chronicles the deep ineptness of Russian organization and command. The infighting between the officer corps within, and their out-of-touch civilian masters in the Tsar’s court contributed to their failure in 1914.

¹¹⁶ Brose, *A History of the Great War*, 75.

¹¹⁷ Stone, *The Eastern Front*, 134. Agnew and others, “Atlas for the Great War,” 31.

¹¹⁸ Stone, *The Eastern Front*, 134.

¹¹⁹ Stone, *The Eastern Front*, 134.

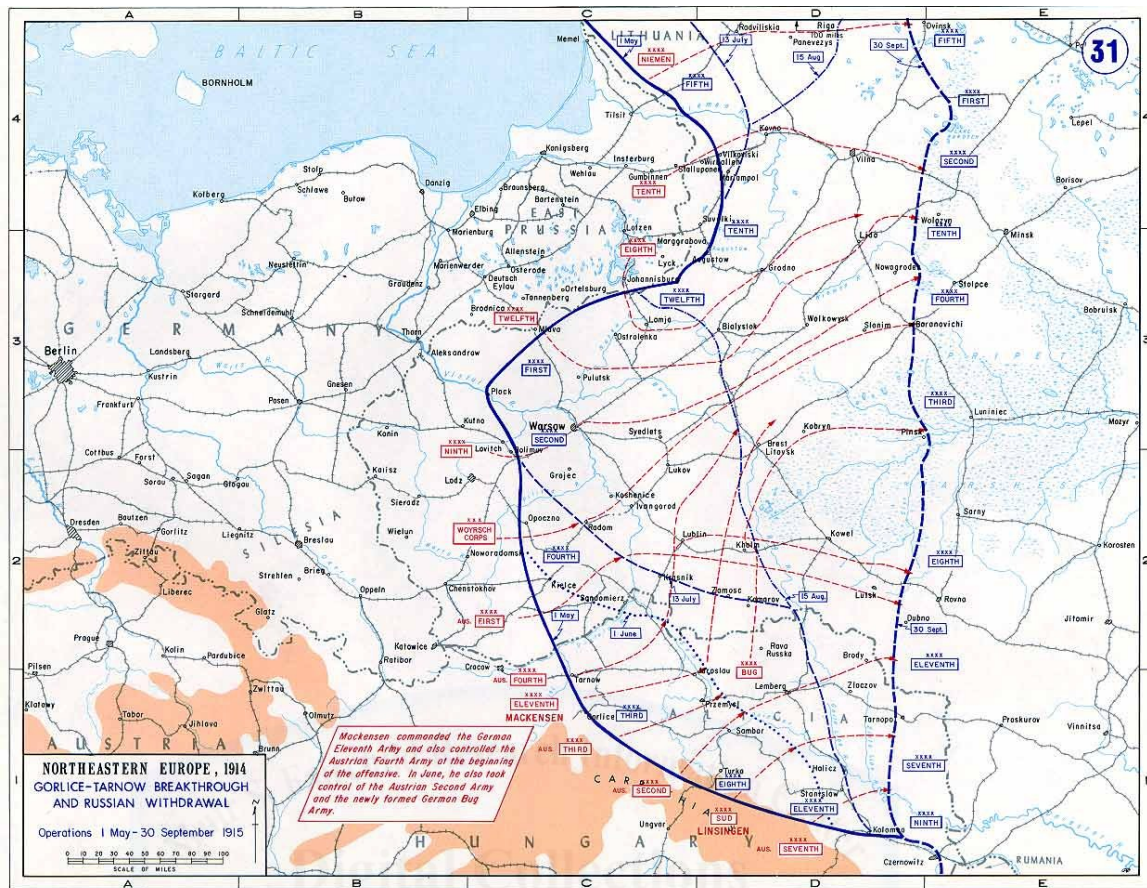


Figure 7: Gorlice-Tarnow Breakthrough

Source: Thomas Griess “West Pont Atlas For the Great War.”

For the remainder of the war, the Eastern Front would follow a pattern similar to these early battles. Both sides would gain offensive advantage by rail once out in the open steppes. The roads for travel by other means—horse or on foot, were generally poor and quickly filled with mud.¹²⁰ However, the great distances involved and the lack of other means of travel would quickly outstrip the LOCs for both sides. Despite the famous victory at Tannenberg, which would haunt both sides well into World War II, the Germans never gained full advantage on the front until 1917. As in the early battles, the needs of the West would beckon.

¹²⁰ Stone, *The Eastern Front*, 182-183. One German commander noted that geography—marshes and flat wet ground—was the limiting factor, not the Russian Army.

With internal Russian affairs collapsing under the Bolshevik Revolution and the German victory at Riga in the fall of 1917 (a combined sea and land victory), the Russians and Germans agreed to an armistice in December 1917.¹²¹ As internal Russian politics drug the discussion for the final peace treaty into the spring of 1918, the Germans moved. Now under the *Eisenbahnmeister* of 1914, General Hoffman, the Germans quickly secured the majority of the Ukraine with a rapid railroad movement, to include Rostov on the black sea, more than 500 miles from the original armistice line.¹²² Mackinder's heartland promised much; in this territory, Germany gained "54 percent of Russian industry, 33 percent of its rail system, 32 percent of its agriculture, and 34 percent of its population."¹²³

Mackinder in his Heartland

The battles in the East took place in the Western section of Mackinder's heartland. Mackinder's geographical stratification of the Heartland's steppes nearly perfectly described the pace of operations on the Eastern Front in three ways—mobility, its natural limits, and its dearth of roads.

First, the heartland's geography gave the advantage to mobile populations, "we have in this immense area all the conditions for the maintenance of a sparse, but in the aggregate considerable, population of horse-riding and camel-riding nomads."¹²⁴ Much the same way as the great hordes had done through history, the Germans, and the Russians road on rails and used horses to press the offensive advantage.

Second, Mackinder recognized western limits to the Heartland. He noted that the old growth forest of Eastern Europe tended to halt the

¹²¹ Brose, *A History of the Great War*, 313.

¹²² Agnew and others, "Atlas for the Great War," 31.

¹²³ Sammartino, *The Impossible Border*, 38.

¹²⁴ Mackinder, "The Geographical Pivot," 429.

steppe's mobility.¹²⁵ Even after the victory at Tannenberg in 1914, the Germans could not pursue the Russians with vigor due to the Masurian district's lake-strewn terrain.¹²⁶ Ultimately, the Russians were able to regroup further East in Poland. Later in 1915, in Eastern Poland, the marshy area described by Mackinder, with its limited railroads, would slow the German advance eastward. War confirmed Mackinder's view of the geographic limits of the Heartland.

Finally, Mackinder avers that the heartland lacks the wood and rock necessary to build roads.¹²⁷ He hopes that railroads, supplied with industrial support, could skip the development necessary to build roads.¹²⁸ On the Eastern Front, the lack of roads held up armies and bogged troops down in mud, and thus the railroad became the critical delivery device.¹²⁹

Mackinder's railroad is the transportation technology for his heartland. For the Eastern Front, railroad technology was so important that both sides learned how to use it beyond the mobilization and delivery of troops to the front, as it had been used during the opening phases of both the West and the East. Since the belligerents had much more space to work with in the East, they learned to adapt the railroad to mobile warfare. The Germans especially adjusted to quickly embarking and debarking from stations, while also moving with less equipment.¹³⁰

Beyond technology, Mackinder hints at the autarkic possibilities of the heartland. During operations on the Eastern Front, this was certainly the case. Despite popular myth, the Russian breadbasket

¹²⁵ Mackinder, "The Geographical Pivot," 429. Mackinder, "The Geographical Pivot of History (Reprint of 1904 Article)," 429.

¹²⁶ Agnew and others, "Atlas for the Great War," 31.

¹²⁷ Mackinder, "The Geographical Pivot," 434.

¹²⁸ Mackinder, "The Geographical Pivot," 434.

¹²⁹ Keegan, *The First World War*, 167. Ludendorff was able to relocate eleven divisions using the rail network in Poland in late October and early November 1914.

¹³⁰ Brose, *A History of the Great War*, 91.

continued to produce enough food for the population. Even with the Western half of the region occupied by Germany in 1917, the Russian harvest amounted to 133,760 million pounds of grain.¹³¹ According to Norman Stone, this “was not too far below pre-war levels.”¹³² The Russians were also able to change their small cottage industries, which local communities had developed over centuries, into fully nationalized industry.¹³³ Railroads were the key to this process, with labor shuffling around the country at a rate of 100 million more passengers in 1916-1917 versus 1913-1914.¹³⁴ Mackinder’s dream of transcontinental railways linking the heartland, agriculture, industry, and commerce was nearly achieved by the Russians before the Bolshevik Revolution.

Unfortunately, for the Germans, the treaty of Brest-Litovsk occurred too late to take advantage of the situation. With the Allied sea blockade tightening and the winter wheat already in by early 1918, there was no chance for the German government to begin extracting wealth and sustenance from the heartland before the war ended. Thus, despite taking advantage of the mobility of the heartland by the use of railroads as Mackinder suggested, the Germans were never fully able to integrate the region for their own use.

Mahan’s difficulties in the East

Even though the British had won control of the Atlantic by 1918, they still could not pass Germany to the East and reach the Baltic Sea. As a result, in addition to their quick railroad movements towards Riga in 1917, the Germans were able to land forces using their navy and blockade the port of Riga.¹³⁵ In one sense, this fits Mahan’s notion of amphibious operations. However, the Germans prosecuted the operation with only very localized sea control, while the British still held

¹³¹ Stone, *The Eastern Front*, 295.

¹³² Stone, *The Eastern Front*, 295.

¹³³ Stone, *The Eastern Front*, 285.

¹³⁴ Stone, *The Eastern Front*, 285.

¹³⁵ Agnew and others, “Atlas for the Great War,” 40.

the entire Atlantic Ocean. Once again, Corbett's notion of localized control of waters held. Despite all the advantages of her great battle fleet, the mine and the submarine kept British forces at bay in the Baltic.

Gallipoli and the Arab Revolt: The LOC War Elsewhere

Churchill favored a 'ships alone' approach, brushing aside the objections of Third Sea Lord Frederick Tudor, who worried that Turkish Mines and shore batteries would prove too formidable an obstacle. 'You won't do it with ships alone,' Tudor ventured, to which Churchill replied, 'Oh yes we will.'

Eric Dorn Brose

Many years later, looking back over her life with Winston [Churchill], Clementine was to say that, of all the events they had lived through together, none had been so agonizing as the drama of the Dardanelles....'I thought he would die of grief.'"

Martin Gilbert, Winston's Churchill's Biographer

There were many fronts on WW1, not just in the Atlantic, the West, and the East. There were operations in Africa, in the Balkans, and in Italy. However, no two campaigns personified the dynamics among Mahan and Mackinder, LOCs, technology, and geopolitics like Gallipoli and the Arab Revolt.

Gallipoli, the failed Allied campaign to take command of the Dardanelles, began with strategic promise in the winter of 1914. As the Western Front settled into trenches following Ypres in November, First Lord of the British Admiralty, Winston Churchill, proposed taking the Dardanelles from the Turks.¹³⁶ In the process, the Allies hoped to secure Greek, Bulgarian, Romanian, and Italian entrance into the war through naval victory, as well as open a warm-water route of supply from the West to Russia.¹³⁷

¹³⁶ Keegan, *An Illustrated History of the First World War*, 217.

¹³⁷ Keegan, *The First World War*, 236-238.

The Dardanelles, only a mile-wide, had long been a key geographic point for sea and land power between Asia and Europe. As John Keegan notes, "The strategic location of the Dardanelles had brought armies, and navies, to it scores of times in history."¹³⁸ The British plan proposed that the Allies take the Dardanelles, sail North through the Sea of Marmara, past Istanbul, and into the Black Sea to resupply Russians in their quest to defeat the Austro-Hungarian armies on the southern flank of the German lines on the Eastern Front.¹³⁹

As the 29-ship Allied armada sailed in February 1915, a successful mission seemed secure, with the Russians promising to attack Istanbul, and Bulgaria stepping away from alliance talks with the Germans.¹⁴⁰ The initial plan called for the Allied fleet, composed of British and French battleships and dozens of minesweepers, to move through the Dardanelles and shell the medieval Turkish forts whose heavy guns pointed straight down on the narrows. As the fleet made its way up the Dardanelles, poor aerial reconnaissance due to rough seas hid many of the mines from the ships, and several went to the bottom.¹⁴¹ The sinkings slowed the fleet and put it at risk to the surrounding guns.¹⁴² By the end of the day on March 18, 1915, the Turks had sunk three battleships, put three more out of action, and inflicted damage on four others.¹⁴³ The Allies found themselves at the mercy of two technologies, the sea mine and coastal artillery, while being betrayed by a third, the internal combustion engine in the form of the airplane.

The failure to proceed through the Dardanelles by ship alone required amphibious landings later in the summer of 1915 to take out

¹³⁸ Keegan, *The First World War*, 234.

¹³⁹ Keegan, *The First World War*, 236.

¹⁴⁰ Brose, *A History of the Great War*, 162.

¹⁴¹ Raul Colon, "Air Effort over Gallipoli: A Brief Look at the Air Campaign over the Dardanelles" <http://www.century-of-flight.net/Aviation%20history/airplane%20at%20war/turk.htm> (accessed 28 February 2012).

¹⁴² Brose, *A History of the Great War*, 164.

¹⁴³ Keegan, *The First World War*, 239.

the Turkish guns on the Gallipoli peninsula. Despite heroic attempts by Allied troops, including most famously Australians and New Zealanders, the Turks, supported by trains that ran from the interior to the Dardanelles, repulsed the Allies. In the words of a geographer deployed to the Dardanelles at the time, "There is a direct route from Smyrna by way of Manisa and Soma to the Sea of Marmora. Its easiest line is now traversed by a railway, debouching at Panderma immediately to the east of the Cyzicene peninsula. It is obvious that whoever holds this line, about 210 miles in length, can turn the Asiatic defence of the Dardanelles."¹⁴⁴ Land LOCs, combined with the peculiar geography of the straits and new technologies in mines and coastal artillery, overcame the Allies' command of the sea.

Mahan's theory has minor success and major failure in describing LOCs at the Gallipoli campaign. From a success perspective, Mahan understood how critical the Black Sea was to world naval strategy, "should any chance add to the control of the Black Sea basin, which Russia now has, the possession of the entrance to the Mediterranean, the existing strategic conditions affecting sea power would all be modified."¹⁴⁵ Thus, he understood the critical nature of the Black Sea and by extension the sea's entrance at the Dardanelles.

As discussed in Chapter 1, Mahan believed position was important, however, he placed greater weight on force, "in the combination of the two factors, force and position, force is intrinsically the more valuable, it is always possible that great advantage of position may outweigh small advantage of force, as 1 + 5 is greater than 2 + 3."¹⁴⁶ Mahan further placed value upon force by conflating force with position: "the sea is not without positions advantageous to hold...The fleet it may

¹⁴⁴ D. G. Hogarth, "Geography of the War Theatre in the near East," *The Geographical Journal* 45, no. 6 (1915): 461.

¹⁴⁵ Mahan, *The Influence of Sea Power*, 13.

¹⁴⁶ Mahan and Hattendorf, *Mahan on Naval Strategy*, xxv-xxvi.

be said is itself the position.”¹⁴⁷ Even after the lessons of the 1905 Russo-Japanese war, where the importance of mines and coastal artillery were demonstrated, Mahan believed that, “The defenses of Port Arthur permitted the tenure of the place by a much smaller number of men than the besiegers were compelled to employ in the sieges...They [defenses] are as essential to sea as to land war; but...they are to be considered inferior to the Army in the field.”¹⁴⁸ Given that the Turks were able to forestall the initial Australian beach assault with less than 200 men, despite heavy shelling from Allied battleships, Mahan appears incorrect. Land position is critical, and naval force has its limits.

Mackinder, in the opposite vein of Mahan, has major success and minor failure in describing the Dardanelles campaign. By using the railroad, the Turkish land power was able to meet and defeat the Allied sea power. In addition, the defender was able to use the technology of the mine and the coastal gun to force the Allies back. For Mackinder, technology was important for, “A city which depends on one physical advantage may fall at any moment. A single mechanical discovery may effect the change.”¹⁴⁹ The Turkish use of modern technologies to defeat a far superior navy represents a Mackinderite view of war.

Despite his belief in land power, as a geographer Mackinder had a *de-facto* negative view of the Dardanelles region. In his theory, the straits are part of the outer or marginal crescent, “To east, south, and west of this heart-land are marginal regions, ranged in a vast crescent, accessible to shipmen...it is marginal, for sea-gulfs and oceanic rivers lay it open to sea-power, and permit of the exercise of such power. From it the steppe-peoples could treat the open tablelands of Iran and Asia Minor as forward posts whence to strike through the Punjab into India, through Syria into Egypt, and over the broken bridge of the Bosphorus

¹⁴⁷ Mahan and Hattendorf, *Mahan on Naval Strategy*, 155.

¹⁴⁸ Mahan and Hattendorf, *Mahan on Naval Strategy*, 127.

¹⁴⁹ Mackinder, "On the Scope and Methods of Geography," 152.

and Dardanelles into Hungary.” He found the region too susceptible to both land and naval invasion.

In World War I, however, land power overcame sea power with the help of technology. The Turkish success brought encouragement for the “sick man of Europe” and emboldened the Young Turk officers in charge of the battle, most notably Ataturk, who would pull the country into the 20th century at the completion of the conflict.¹⁵⁰

While the Dardanelles represented a classic force-on-force operation, the Arab revolt followed much more in-line with classic amphibious operations in the model of the British Empire. An Arab-manned land force organized against the Turks and commanded by T.E. Lawrence was able to harass the tenuous Turkish railroad lines in the Middle East. While supplied by the British Navy from the Red Sea, Lawrence led Arab forces on a daring raid overland to attack Aqaba in June 1917, which had a “relatively undefended inland rear.” (See Figure 8).¹⁵¹ This stunning success allowed British supplies to reach Aqaba and form a base for operations into present-day Israel. Ultimately, the victory at Aqaba led to the capture of Jerusalem and a repulse of the Ottomans from Palestine.¹⁵²

Both Mahan and Mackinder’s theories can describe the success of the Arab Revolt and British operations in Palestine. For Mahan, amphibious operations are one of the critical areas granted by command of the sea.¹⁵³ In this case, once Lawrence’s army took Aqaba, the British then used the city to form a base from which to support further incursions inland. In addition, without the logistical support the British supplied to Lawrence and his Arab army, they could not have pulled off their raids or the seizure of Aqaba. In essence, the fleet became the position for Lawrence’s land LOC, much as Mahan posited.

¹⁵⁰ Keegan, *The First World War*, 246.

¹⁵¹ Brose, *A History of the Great War*, 298.

¹⁵² Brose, *A History of the Great War*, 305.

¹⁵³ Mahan, *The Influence of Sea Power*, 296.



Figure 8: The Arabian Campaign

Source: Greiss, West Point Atlas for the Great War.

Although Mackinder believed the railroad to be the key modern transportation method for land power, he also understood that rail was susceptible to attack. Due to this weakness, Mackinder believed the heartland needed isolation from sea power to realize its power. Even his great Russian Trans-Siberian Railway was “still a single and precarious line of communication.”¹⁵⁴ The vulnerability of Turkish railway lines (See Figure 8) represented this same problem during World War I. Beyond the risk of a single rail LOC, the Middle East, much like the Dardanelles, is too circumscribed by sea power for Mackinder’s liking.¹⁵⁵

¹⁵⁴ Mackinder, “The Geographical Pivot,” 434.

¹⁵⁵ Mackinder, “The Geographical Pivot,” 432.

Conclusion

In the end, those who commanded the sea prevailed over those who had belatedly gained control of the heartland during World War I. Timing and technology proved as critical as geography to all three of the areas of conflict. A shorter delay at the Belgian forts and a little more “give” from the German center in Alsace-Lorraine might have produced a different result in the West. Similarly, better coordination between German and Austro-Hungarian armies in the East might have produced decisive results early enough to capitalize on the resources available in the region. In the Dardanelles, better amphibious doctrine and an imperative to get off the beaches might have propelled the Allies to victory despite the mines and forts.

Moreover and perhaps to the chagrin of our sea and rail-minded theorists, the three fronts described here were highly interactive. Russian success in East Prussia prompted a weakening of the right wing of the attack in the West and the waste of troops in transition by rail between the fronts. A preoccupation with success in the West kept Germany on the defensive in the East in both 1914 and 1916. The Gallipoli campaign resulted from both a stalemate in the West and a desire to reinforce Allies on the Eastern Front. Failure there resulted in a flank attack on the “sick man of Europe” in Palestine.

The “systemic” nature of rail and sea transportation networks represents perhaps the most correct view of this global war and the relationship of its several fronts. Here Corbett and Mackinder appear to have more explanatory power than Mahan does, since both recognized the need for multiple modes of transportation through different mediums to actualize the logistics of war.

Both rail and sea power conferred strategic advantages that were local in nature, and neither was particularly useful in connecting strategic intent to tactical success. The missing link here proved to be the internal combustion engine—still in need of much refinement but

showing a great deal of promise by the war's end. Further development of the internal combustion engine, manifested in trucks, tanks, and aircraft, would form the critical bridge between strategy and tactics in the next major conflict. And not too surprisingly, the control of sources of oil to fuel these machines became the strategic imperative for both the next war and its aftermath. Since the air medium circumscribes both land and sea, refinements to flying machines demonstrated great potential to legislate the standoff between rail and sea-supplied forces that typified much of World War I. The air also held a great deal of promise as a line of communication and mode of logistics. Technical refinements, however, in aerodynamic design, engine technology, and delivery modes stood in the way of aircraft competing with ships, trains, and trucks as efficient haulers. Although great strides were made in time for the next major war, many of these deficiencies in air LOCs still exist. Nonetheless, it was the ability to deliver goods and services by the all-encompassing medium of the air that would provide the decisive margin of victory in the next global war.

Chapter 4

Lift for Lines: Douhet, Mitchell, and Air Communications

The airplane began World War I as little more than a novelty. The crucible of war changed aircraft technology so much that “the airplane of 1914 viewed from 1918 was as ancient and extinct as an archaeopteryx.”¹ Technological advance also brought the aircraft expanding missions, from intelligence gathering, air superiority, and long-range bombing, to hauling people and materiel.

Mackinder believed the airplane irrevocably changed the relationship between sea and land LOCs. Updating his original theory put forth in 1904 in *The Geographical Pivot Point*, with the lessons of World War I, he wrote *Democratic Ideals and Reality: A Study in the Politics of Reconstruction*. In his updated manuscript, Mackinder put the aircraft at the center of his Heartland-based land LOC model. He states, “Four centuries ago the whole outlook of mankind was changed in a single generation by the voyages of the great pioneers Columbus Da Gama and Magellan...A similar revolution is in progress in the present generation in the rapid realization of the unity of the Continent owing to modern methods of communication by land and air.”²

As much as the railroad represents Mackinder’s pre-war concept of the idealized land LOC transportation, the airplane is his post-war sea power equalizer: “In the days of air navigation, which are coming, sea-power will use the water way...only by the sufferance of land-power, for air-power is chiefly an arm of land-power, a new amphibious cavalry,

¹ Lee Kennett, *The First Air War: 1914-1918* (New York: Simon and Schuster, 1991), 93-94.

² Halford J. Mackinder, *Democratic Ideals and Reality* (New York: Henry Holt, 1919), 90.

when the contest with sea-power is in question.”³ Mackinder’s dialectic approach between land and sea LOCs remains. Land and sea are the two primary powers, with air as arbiter on the side of the land.

The impact of a new air domain, political changes, and technological improvements, all birthed by the Great War, altered Mackinder’s closed system. The world’s citizens, for good or ill, now thought of themselves as part of a wider world connected by the steam ship, the airplane, and the telephone.⁴ For Mackinder, this portended an ominous future of globalized struggle between sea and land power.⁵

Given these changes, Mackinder altered his view of the heartland. Rather than have the heartland as part of Eastern Europe and Western Asia, Mackinder firmly placed the heartland at the center of the World-Island, which encompassed all of Asia, Africa, and Europe. The other continents, e.g. North America and Australia, were smaller islands encircling the World-Island.⁶

Now the heartland was at the center of the entire world. Mackinder’s famous dictum then followed, “Who rules East Europe commands the Heartland: Who rules the Heartland commands the World-Island: Who Rules the World-Island commands the World.”⁷ Mackinder’s thoughts resonated within the turbulent international political environment between the wars. Much to Mackinder’s later dismay, Hitler echoed many of his ideas, “[i]f I had the Ural Mountains with their incalculable store of treasures and raw materials, Siberia with

³ Mackinder, *Democratic Ideals and Reality*, 81.

⁴ Mackinder, *Democratic Ideals and Reality*, 90. Mackinder states, “The idea of the unity of the ocean beforehand merely inferred from the likeness of the tides in the Atlantic and Indian waters suddenly became a part of the mental equipment of practical men.”

⁵ Mackinder, *Democratic Ideals and Reality*, 140.

⁶ Mackinder, *Democratic Ideals and Reality*, 79-80.

⁷ Mackinder, *Democratic Ideals and Reality*, 186. In many instances, this quotation is incorrectly conflated with Mackinder’s *Geographical Pivot* theory. Since he wrote the quotation in 1919 in *Democratic Ideals and Reality*, it shows how Mackinder understood that the technological changes of World War I linked the world much more closely and set the stage for a much bigger sea-land battle.

its vast forests, and the Ukraine with its tremendous wheat fields, German and the National Socialist leadership would swim in plenty.”⁸

The advances of airpower in World War I spawned theories in Italy, Britain, and Russia, but the airplane as a laborsaving device in warfare found perhaps the most traction in the United States, whose frontier progressive mentality reveled in the new technology.⁹ In its violent persona, the airplane represented a technological solution to the labor-intensive exercise of war through strategic bombing. In its more benign form as a conveyance, the airplane promised fast transportation across a large continent and a way to reach out to the world. Italian airpower theorist Giulio Douhet emphasized the violence of the new technology while American Billy Mitchell advocated its potential for both commerce and war, while recognizing the airplane’s capacity for both direct and supporting activities in combat. Douhet and Mitchell moved airpower in two differing directions. Douhet hearkened back to Mahan, establishing air as the one and only true power. Mitchell moves Mackinder’s airplane from mere arbiter of sea LOCs, in favor of land LOCs, to an LOC in its own right.

To Command a Fluid Medium: Mahan and Douhet

Go Ahead! Try to advance through the harsh mountainous country, conquering it foot by foot and soaking it with your generous blood...Go ahead, and be patient if we cannot send you arms and munitions, because the enemy is destroying our factories, warehouses, and lines of

⁸ As Quoted in Gerry Kearns, *Geopolitics and Empire: The Legacy of Halford Mackinder* (New York: Oxford Press, 2009), 18.

⁹ Michael L. Smith, "Recourse of Empire: Landscapes of Progress in Technological America," in *Does Technology Drive History? : The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge, Mass.: MIT Press, 1994), 38. Smith documents American fascination with technology, "In the United States, generations of leaders and pundits have mistaken technology for the answer, rather than the question." Colin S. Gray, *Explorations in Strategy*, Contributions in Military Studies, (Westport, Conn.: Greenwood Press, 1996), 87-89. Gray lists eight attributes of American culture that make the nation predisposed to airpower (versus land or sea power). For example, Americans tend to prefer engineering or technological solutions to problems. As a high-end technology, the airplane, and by extension airpower, offer such a technological tool.

communication from the air....We have tried in vain to dominate the oceans...Go ahead and win!

Giulio Douhet

Douhet was airpower's first and still is its foremost theorist. As Bernard Brodie remarked in 1959 in his work *Strategy in the Missile Age*, "Brigadier General Giulio Douhet possessed the largest and most original mind that has thus far addressed itself to the theory of airpower."¹⁰ From Cold-War bomber and missile forces, to Vietnam air campaigns, John Warden's five-rings theory executed during *Desert Storm*, to operations in Afghanistan in 2012, they all search for Douhetian notions of airpower. Simply put, Douhet posits that air bombing's violent effects can influence the enemy's psychology in such a manner to cause political capitulation. For Douhet, one had simply to destroy enough targets to cause the enemy sufficient suffering.

Douhet's classic work, *The Command of the Air*, looks back to the horrors of World War I and sees "a long-drawn-out war which almost completely exhausted both victor and vanquished."¹¹ Douhet blames this on technology, which gave new power to the defense without subsequent rethinking by the belligerents, who were stuck in an offensive mentality.¹² Not only was old thinking about warfare wrong, but also the airplane had actually changed the nature of war.¹³

Douhet turns Mahan's technological views on their head. Where Mahan looks to the past to find principles which are impervious to technological change, Douhet looks to technology to save civilization from its past and warns, "woe to him who tries to fight the war of the future with the theories and systems of 1914!"¹⁴ Thus like Mackinder, Douhet's writing is tinted with technological determinism.

¹⁰ Bernard Brodie, *Strategy in the Missile Age*, New RAND ed. (Santa Monica, CA: Rand Corp., 2007), 71.

¹¹ Douhet, Harahan, and Kohn, 10.

¹² Douhet and others, *The Command of the Air*, 10-11.

¹³ Douhet and others, *The Command of the Air*, 15.

¹⁴ Douhet and others, *The Command of the Air*, 206.

In much the same way that the World War I belligerents believed modern weapons gave advantage to the offense, Douhet believes future warfighters will ignore the offensive capability of the airplane. He states, “The airplane is the offensive weapon par excellence.”¹⁵ Douhet then lays out a detailed plan on how the Italian nation should organize itself for future conflict.

First, Douhet believes the purpose of air war is “command of the air,” (in modern terms, air superiority).¹⁶ After command of the air, “aerial forces should direct their offensives against surface objectives with the intention of crushing the material and moral resistance of the enemy.”¹⁷ As part of this destruction, no technological means should be spared for, “the efficacy of destructive materials should be increased as much as possible...the offensive power of an Independent Air Force is in direct proportion.”¹⁸ Finally, Douhet believes in continued “violent, interrupted action against surface objectives” towards his ultimate objective to “crush the material and moral resistance of the enemy.”¹⁹

Through direct action against the enemy’s population, Douhet elevates his theory to one of geopolitical significance that argues for independence of the air arm. Although he does talk about the necessity of working with the Army and Navy, as necessary, the implications of his ideas are clear.²⁰ Why would a nation need an Army or Navy if they could end any war, with any state, quickly by air attack?

As Mahan does for sea power, Douhet elevates air power to the top of the state’s military pedestal.²¹ Airpower attacks all other LOCs. More

¹⁵ Douhet and others, *The Command of the Air*, 15.

¹⁶ Douhet and others, *The Command of the Air*, 128.

¹⁷ Douhet and others, *The Command of the Air*, 128.

¹⁸ Douhet and others, *The Command of the Air*, 128.

¹⁹ Douhet and others, *The Command of the Air*, 129.

²⁰ Douhet and others, *The Command of the Air*, 5. Douhet states, “An air force should logically be accorded equal importance with the army and navy and bear the same relation to them as they now bear to each other.”

²¹ Brodie, *Strategy in the Missile Age*, 77-79. Brodie does not believe Mahan and Douhet warrant comparison. Much as discussed in Chapter 1, Brodie sees Mahan

pointedly, airpower exists only to rain destruction on the enemy. Providing LOCs in support of other services is superfluous.

Unlike Mahan, Douhet does not view air power as protector of economic and military LOCs. In fact, Douhet views the commercial development of runways, navigation systems, and transportation aircraft as supplements for wartime offensive bombing. In other words, the commercial supports the military. He says, "Civil aviation should be so organized as to be utilized as a complement to military aviation in case of war."²²

Beyond Mackinder: Mitchell

"The influence of air power on the ability of one nation to impress its will on another in an armed contest will be decisive. Aircraft of certain classes are now able to traverse the air all over the world no matter whether they be over the sea or over the land." -- William "Billy" Mitchell, *Winged Defense*²³

While Douhet concentrates on the airplane's destructive power, Billy Mitchell focuses more effort on both peacetime and wartime aviation. From a peacetime perspective, Mitchell views the airplane as the new transportation medium for the United States. He declares, "Transportation is the essence of civilization."²⁴ For a still rural nation, the United States in the 1920s, Mitchell believes air transportation can help link the country and bring development to regions, which "have made no advance in their cultural state but have retrogressed."²⁵

As part of this new transportation medium, Mitchell envisions a system which is uninhibited by geography as land and sea LOCs are for

sticking to unchanging principles, while Douhet sees that technology and warfare have changed much. The author does not wish to get in an intellectual contest with Brodie, however even though Mahan and Douhet differ in method, they still both see their mode of power as the only mode of power.

²² Douhet and others, *Command of the Air*, 128.

²³ William Mitchell, *Winged Defense; the Development and Possibilities of Modern Air Power - Economic and Military*, 2009 ed. (Tuscaloosa: The University of Alabama Press, Fire Ant Books, 1925), 214.

²⁴ Mitchell, *Winged Defense*, 77.

²⁵ Mitchell, *Winged Defense*, 77.

“no condition of this kind confronts aircraft as the air is a common medium all over the world.”²⁶ Given the limitless capabilities for the airplane, Mitchell avers that the US government should organize a system to move passengers and freight across the country because heretofore, “no system for the development of commercial aviation has ever been developed,” while Europe at the time had a robust system integrating people and goods through a common air transport system.²⁷ Through such a system, Mitchell hoped to strengthen the US economy, which in his view had a robust manufacturing capability but lacked the transportation to deliver to domestic and foreign markets.²⁸

As part of his economic analysis, Mitchell examines various air technologies, not just the airplane. He concludes that the airplane is a fast mover of people and goods, but not as cost-efficient as other means such as airships. He declares, “The Germans...had perfected their dirigibles...so that it is said that over two hundred thousand passengers were carried by these ships without accident. The cost per passenger miles is very much less in lighter-than-air-ships than it is in airplanes and the limit of cheapness has not yet been attained.”²⁹

Through his examinations of the cost of air transportation, Mitchell articulated the limits of Air LOCs: airlift could get their very fast but at great cost and noticeably smaller cargo loads than land and sea. Given airlift’s cost, Mitchell envisioned another technology, the airship, as an important part of his airpower theory. For commercial LOCs, this meant using airships to transport goods, which also required the build-up of ground facilities to handle their large size.³⁰ For military LOCs, the economic cost of moving goods by air split the air power

²⁶ Mitchell, *Winged Defense*, 78.

²⁷ Mitchell, *Winged Defense*, 88-89.

²⁸ Mitchell, *Winged Defense*, 77.

²⁹ Mitchell, *Winged Defense*, 90.

³⁰ Mitchell, *Winged Defense*, 90-93. Mitchell describes the integration of airships into a national flying system. He believes the US government must take the lead in developing the necessary policies and infrastructure for commercial aviation.

mission into two areas: transportation and kinetic operations. Airships were to transport “goods, supplies, and men,” while also serving as launching hubs for pursuit and bomber aircraft which would perform their missions and return—in essence functioning as an aircraft carrier of the air.³¹ First stated by Mitchell in the 1920s, these economic arguments for the limitations of aircraft lift still apply today.³²

Moving beyond his commercial ideas, Mitchell pitted the technology of the airplane against the technology of the ship. In Mitchell’s view, World War I had shown that the world was entering the “aeronautical era.”³³ The airplane changed the old ways of land and especially sea warfare.

The title of Mitchell’s third chapter in *Winged Defense* sums up his view, “The United States Air Force Proves That Aircraft Dominate Seacraft.” In this Chapter, Mitchell describes the missions the Naval Air Service and the US Army Air Corps flew against captured World War I German vessels—from submarines, to destroyers, to the vaunted dreadnaught *Ostfriesland*.³⁴ The air bombing missions sank each ship in short order. Mitchell states, in polemic style, that the test bombing missions “conclusively proved the ability of the aircraft to destroy ships of all classes on the surface of the water.”³⁵

Mitchell attacks the surface navy’s usefulness, not just in terms of airplane technologies, but also the submarine. While battleships stayed out the war, unless as convoy escort (See Chapter 3), submarines “sank

³¹ Mitchell, *Winged Defense*, 39.

³² United States Transportation Command, *2009 Annual Command Report*, 3. In the commercial sense, industry carries goods that are expensive, light, and/or time-sensitive by air (such as precious jewels or people), while deferring to sea, rail, or truck for heavy goods (such as coal or agricultural projects). On the military side, this has evolved to a system in which air carries personnel for the US, while sea carries over 90% of the rest of the cargo.

³³ Mitchell, *Winged Defense*, 3.

³⁴ Mitchell, *Winged Defense*, 42-43 and 56-76. Mitchell describes in detail the *Ostfriesland* sinking in the earlier pages.

³⁵ Mitchell, *Winged Defense*, 73. Detractors from Mitchell’s test would note that the weather was calm and that the ships were not moving—highly dubious environments to test future battlefield success.

sixty-two British warships and eight large French and Italian ships.”³⁶ Couple submarine technology with the fact that “battleships and surface craft are helpless against aircraft unless they themselves are protected by air power,” and Mitchell completes his argument against a large, expensive, surface Navy.³⁷ In Mitchell’s analysis the US Navy was no longer needed for coastal defense, US Army Air Corps air power could it.

It is important to put Mitchell’s argument in context. Mitchell fought for airpower, and an independent air force, in a US political environment. Rather than work within the military, he used the public court of opinion, to persuade Congress to give more funding to the Air Corps.³⁸ As Mitchell understood, any increase in the Air Corps budget would have to come from the other service—the United States Navy. Thus, the US Navy surface battle fleet with its expensive ships that went largely unused in the Great War was a prime target.

With his emphasis on the power of the air versus that of the sea, Mitchell subverts Mahan’s importance of geography. He says, “The Panama Canal, according to the old navy theory, is an extremely important position because it allows fleets to move from the Atlantic to the Pacific Ocean, without having to go around South America...however sea power can accomplish very little except through submarines, in an offensive way, and next, the Panama Canal can be put out of business without much trouble by air attack.”³⁹ Thus, in Mitchell’s thinking, airpower could overcome the advantageous geography of sea power, e.g. the Panama Canal, and controls the sea LOC from the air.

In similar fashion, Mitchell believed air power could control land LOCs. He recounts a mission in World War I in which his air group

³⁶ Mitchell, *Winged Defense*, 99.

³⁷ Mitchell, *Winged Defense*, 100.

³⁸ Tami Davis Biddle, *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas About Strategic Bombing, 1914-1945* (Princeton: Princeton University Press, 2002), 137.

³⁹ William Mitchell and Lyman L. Woodman, *The Opening of Alaska*, 2nd ed. (Missoula, Mont.: Cook Inlet Historical Society, 1988), 1-2.

located the “German center of supply at Fere-en-Tardenois.”⁴⁰ With the help of British aircraft, the Americans destroyed many of the ammunition dumps around the area forcing the Germans to halt their advance.⁴¹ In another example, Mitchell cites the British use of airplanes to facilitate the post-War occupation of Iraq “in a manner similar to that in which armies have in the past.”⁴² Similar to the case for sea LOCs, land LOCs had no hope against air power.

In Mackinderite fashion, Mitchell sees air power as an arbiter, in terms of defense, against LOCs. Air power can interrupt LOCs from any point on the battlefield all the way back to their point of origin. Unlike Mackinder, however, Mitchell does not hold a bias for the airplane in favor of land over sea power. He rather prefers to visualize the air as its own LOC. In doing so, Mitchell moves beyond Mackinder and into the airplane’s offensive capabilities.

Like Douhet, Mitchell sees the airplane as an important tool to strike deep into the homeland of the enemy. Both theories want to use airpower to avoid the horrors of industrial warfare, recently demonstrated in World War I. Where Mitchell differs from Douhet is in the target set.

Douhet wants to use the air weapon to maximize the suffering of the enemy population, to include using gas.⁴³ Mitchell wants to strike, “the hostile nation’s power to make war...this means the manufactories, the means of communication, the food products, even the farms, the fuel and oil and the places where people live and carry on their daily lives.”⁴⁴ Thus, Mitchell defers from attacking the population as a primary target; his theory concentrates the attack on those targets necessary to run an industrial war economy.

⁴⁰ Mitchell, *Winged Defense*, 200.

⁴¹ Mitchell, *Winged Defense*, 202.

⁴² Mitchell, *Winged Defense*, 23.

⁴³ Douhet and others, *Command of the Air*, 20.

⁴⁴ Mitchell, *Winged Defense*, 126-127.

Douhet and Mitchell both appealed to the United States in the inter-war years. As Colin Gray notes in *Explorations in Strategy*, America has always been a primarily airpower nation.⁴⁵ Although possessing a vast seaboard on two oceans, the nation has never had a love for the sea when compared to the air.⁴⁶ Born of the push past western frontiers in an environment scarce on labor, the American fascination with technology found its perfected form in the airplane. Douhet's and Mitchell's promises, in which the airplane wipes clean the old ways of war, thus held much appeal for American military planners in the build-up to World War II.

All Together Now: Sea, Land, and Air LOCs

Alfred Thayer Mahan died only 4 months after the First World War started. Unlike Mackinder, he was unable to adjust his thoughts on sea power to recent wartime experience. Mahan correctly predicts the influence of sea power, but not the technical and tactical methods by which the belligerents attempted to gain command and use of the sea. As time and invention march on toward the Second World War, the technological limitations of Mahan's theory will become starker.

Halford Mackinder's post-war updates—the "World-Island" and air power as an arbiter for Land LOCs against Sea LOCs—hold more promise for analysis in World War II. The Heartland is still central, but the contest is now a final confrontation between sea and land LOCs for world dominance.

Douhet and Mitchell add the air LOC to the picture. Douhet promises air power as LOC destroyer, rather than military protector and commercial enabler. Unlike the old methods of sea and land, Douhet's airpower concerns itself less with the destruction of enemy communications and more with erosion of his morale. Mitchell posits that the airplane has a commercial and a military aspect, much like

⁴⁵ Gray, *Explorations in Strategy*, 83.

⁴⁶ Gray, *Explorations in Strategy*, 85.

Mahan holds for the sea. On the commercial side, Mitchell sees the airplane as the transportation medium for the new world, linking the United States internally and bringing products to foreign markets. On the military side, Mitchell has two views: Defensive and Offensive. On defense, Mitchell believes the airplane can attack and disrupt Sea and Land LOCs. On offense, Mitchell takes a more Douhetian approach.

Pondering the theoreticians of land, sea, and air raises three key questions about the coming conflict at mid-century. First, does command of the sea still afford the same benefits for the side that holds it? Second, can the uniting of the heartland and the use of the airplane bring Mackinder's World Island to primacy? Finally, how will air power legislate outcomes between land-centric and sea-centric polities?



Chapter 5

World War II: Consumption, Supply, and Arbitration

None of the participants could operate in the world-wide conflagration as it preferred; all had to adjust to the necessities—even the terrors of the moment.

Gerhard Weinberg

The most wanton and luxurious household cannot compete with a battlefield in rapid consumption

Lewis Mumford

With no far-flung empires to chase, the nations within Mackinder's closed system turned on themselves for political power, resources, and most notoriously *Lebensraum* during the Second World War. As they began the conflict, improved war fighting technologies, such as the tank and the aircraft gave the belligerents increased lethality, range, and mobility. For the first time in history, nowhere in the closed system was untouchable.

Such a closed, interconnected, and reachable world influenced the logistics of the war in two ways. First, the struggle for lines of communication (LOC) dominance in one region had large geopolitical ramifications in another. For example, the German invasion of the Low Countries in 1940 and subsequent routing of the British from the European continent gave the British government strategic pause in the Pacific. When the Japanese demanded the British close the Burma-India road, which supplied the Chinese, in July 1940, Britain relented.¹ In other words, the German denial of the British sea-land communications connection to the European continent set the conditions for the Japanese to interdict the land supply of their Chinese nemesis through diplomacy.

¹ Gerhard L. Weinberg, *A World at Arms : A Global History of World War 2* (Cambridge Eng. ; New York: Cambridge University Press, 1994), 168. This is not to indicate that the British considered the supply of the Chinese a critical component to their overall global strategy, but the German success at Dunkirk made them much less likely to protest the Japanese request.

Second, a reliance on a single line of communication would be impossible. Belligerents had to network all technology at their means to support their own communications or destroy those of their enemies. Late 1930s technology allowed nations to attack or maintain LOCs in ways unimaginable during World War I. For example, long-ranging German U-boats interdicted US ships in American ports in early 1942, the Germans resupplied the beleaguered sixth Army at Stalingrad by air, and the Allies airdropped troops for a land campaign into the Netherlands in 1944. The requirement to integrate combat power and logistics demanded proper supply chain management.

Although a more modern term, supply chain management is a useful rubric to analyze World War II logistics. Supply chain management, in a wartime context, traces much of its thought back to three of the theorists discussed in the first four chapters: Mahan, Mackinder, and Mitchell. Each theorist forms the intellectual basis for early thinking about the supply chain on the sea and land, and in the air.²

Mahan describes his sea version of a supply chain in *The Influence of Seapower Upon History*, as “three things—production, with the necessity of exchanging products, shipping, whereby the exchange is carried on, and colonies, which facilitate and enlarge the operations of shipping and tend to protect it by multiplying points of safety.”³ Translated into a more modern textbook definition, supply chain management is, “The design and management of seamless, value-added process across organizational boundaries through the integration of people and technological resources to meet the real needs of the end

² Mahan, *The Influence of Sea Power Upon History: 1660-1873*, 28.

³ Mahan, *The Influence of Sea Power*, 28; Mackinder, "The Geographical Pivot of History (Reprint of 1904 Article)," 434.; William Mitchell and Robert S. Ehlers, *Winged Defense; the Development and Possibilities of Modern Air Power - Economic and Military*, 2009 ed. (Tuscaloosa: The University of Alabama Press, Fire Ant Books, 1925), 77

customer.”⁴ Transposing this definition into a military context, supply chain management is the harnessing of national industrial capability, with combat power, logistics, and technology across sea, land, and air domains to supply the needs of war.

A basic supply chain contains three basic steps: securing raw materials, industrial production of those materials, and distribution of those goods to market.⁵ Moving these steps into wartime, a supply chain comprises resources, industrial capacity, and the transportation of materiel, weapons, and people to the battlefield—Lewis Mumford’s ultimate consumer. There are two types of supply chain integration: Vertical and Horizontal. Vertical supply chain integration is the degree to which one country controls and improves the three elements internally.⁶ Improved vertical integration means a given country is better able to control the links from resources through production to final delivery. Horizontal (or strategic) integration is the degree to which countries integrate across national lines to combine their assets and move goods and services on a regional or global scale.⁷ Horizontal integration happens through the acquisition of capability, through invasion, or by alliance.

In World War II, those belligerents who best networked their industrial supply chains with their LOCs and combat power, won battles, campaigns, and eventually the war—most notably the US and the Soviet Union. Since developed industrial economies were engaged,

⁴ Stanley E. Fawcett, Lisa M. Ellram, and Jeffrey A. Ogden, *Supply Chain Management: From Vision to Implementation* (Upper Saddle River, NJ: Pearson Prentice Hall, 2007), 519.

⁵ John Joseph Coyle, Edward J. Bardi, and C. John Langley, *The Management of Business Logistics : A Supply Chain Perspective*, 7th ed. (Mason, Ohio: South-Western/Thomson Learning, 2003), 14. Supply chains can have more than just these three steps to included warehousing, customer service, purchasing, and forecasting.

⁶ Coyle, *The Management of Business Logistics*, 589. See Figure 16-7

⁷ Coyle, *The Management of Business Logistics*, 589-590. The author states, “this type of collaboration refers to business arrangements that have parallel or cooperating positions in the logistics or supply chain process.”

the conflict demanded that nations supply the great consumer—war—in a more sophisticated manner.

Undergirding this requirement for networked communications and supply chains were the vast improvements in technology the world economy of 1939 produced. Table 1 below lists the technology levels at the start of the war. When compared with the World War I technologies listed in Chapter 3, the contrast is striking. In all three domains, technologies allowed militaries to strike at much longer distances, move at a quicker pace, and extend their range. Much like World War I, the consumption of war would demand even further improvements in technology, rendering the figures in Table 2 antique by 1945.

The most significant technological improvement in the inter-war years was airpower. Unlike the unsafe and unsure wire and wood contraptions that defined 1914 aircraft, belligerents of the Second World War now had advanced aircraft as full-fledged war partners. Technological advancements in engine power and design allowed airpower to serve as the great arbiter amongst sea and land LOCs. By the end of the war, particularly with the advent of the atomic weapon, the internal combustion engine in the form of the airplane could destroy any target, anywhere on the planet.

	Power Source	Length	Speed	Range	Kinetic Reach
Submarine	Internal Combustion	240 FT	18 KT _s /8 KT _s	7500NM	2 - 6 NM
Fighter Aircraft	Internal Combustion	30 FT	315 KT _s	400NM	250 YDS (Gun) / 2,000 FT (Bomb)
Bomber Aircraft	Internal Combustion	74 FT	220 KT _s	2000NM	15,000 FT (Bomb)
Aircraft Carrier	Fuel Oil to Steam	746 FT	34 KT _s	7,750 NM	520 NM (Max Aircraft Range)
Railroad	Coal to Steam	N/A	40-50 KT _s	N/A	N/A

Table 2: 1939 Representative Technologies

Source: Stephen Bungay, *The Most Dangerous Enemy*; Wikipedia; Gudmundur Helgason, "German U-Boat VII Type" <http://www.uboaat.net/types/viic.htm>

One and Done: Mahan, Mackinder, Mitchell, and Douhet

In World War I, breaking out the different geographic regions and then analyzing them through the lenses Mahan and Mackinder was straightforward. In World War II, the interconnectivity between theaters and the necessity for belligerents to network sea, land, and air LOCs while considering the national supply chain, makes any such analysis fractured. In fact, Gerhard Weinberg's masterful treatment of the global war suggests that any regional analysis would misrepresent the interconnectivity of the main theaters of operation. Nonetheless, Theodore Rupp's taxonomy for World II—the Second Anglo-German War, The Great Patriotic War, The Great Pacific War, and the Asian

Land War—will serve as basis to test the impact of technology on logistics and the conduct and outcome of the war.⁸

While Mahan, Mackinder, Douhet, and Mitchell do anticipate pieces of the war's execution and outcome, the dominance of single-medium logistics proved insufficient for success in World War II. Those nations, most notably the US and the Soviet Union, which integrated their supply chains both horizontally and vertically, while networking combat capability and LOCs across sea, land, and air domains, won the war. Those nations that required external resources, and thus parasitic horizontal supply chains, coupled with more narrow conceptions of LOCs and combat power—Germany and Japan, respectively—lost.

The War for East Asia

With regard to the war as a whole, the Red Army led by the Chinese Communist Party can at present only play a vanguard role, it cannot yet play a decisive role on a national scale. Nevertheless its political, military and organizational merits are well worth acquiring by friendly armies [Chiang Kai-shek's Nationalist Army] throughout the country.

Mao Tse Tung

The Japanese and Chinese began their entry into World War II, eight years earlier than the other nations. For Japan, an island nation with ambitions for power in the Pacific region, the war would always be about two intertwined issues: resources and China. Although many belligerents were resource-constrained during the war, Japan suffered the most acutely. As a result, rather than simply projecting power from its industrial base outward via a line of communication, Japan had to project power to obtain resources. This parasitic supply chain, which needed outward horizontal, or strategic, integration, took great resources in itself to maintain. The Japanese also lacked full vertical integration of their resources, war industry, and military forces.

⁸ Theodore Ropp, *War in the Modern World*, New, rev. ed. (Baltimore, MD: John Hopkins University Press, 2000), 314.

Instead, they had an extremely politicized and bureaucratic supply chain unsuited for the vagaries and exigencies of twentieth century industrial warfare.⁹

In 1931, Japan took over Manchuria and installed a puppet government designed for resource extraction. After six years of small fights within China, the Japanese attacked South and Westward from Manchuria in 1937 kicking off the Second Sino-Japanese War.¹⁰ For the rest of the war, in China with forays into other Southeast Asian neighbors, Japan's strategy revolved around resources and logistics. The same held for Japan's ally, Germany, and its foes, the Americans and the British, and its uneasy neutral, the Soviet Union.

Japan's foray into Manchuria and Northwest China put the nation in direct conflict with Stalin's interest in the region. In fact, Japanese forces had brief engagements against the Soviet Union in 1938 and 1939.¹¹ Throughout the rest of the war, the Japanese would seek to keep the Soviet Union neutral in the Pacific. As a result, the Japanese ended up aiding the Soviet Union logistically against its future ally, Germany.¹² While Hitler hoped the Japanese Navy would present a drain of resources for Allies in the Pacific, instead the Japanese eventually allowed the US to send more than forty-seven percent of its aid to the Soviet Union through the Pacific unimpeded.¹³ Thus, the Japanese allowed the Allies the ability to integrate US industrial capacity with that of the Soviets as well as the latter's considerable

⁹ Mark R. Peattie, *Sunburst: The Rise of Japanese Naval Air Power, 1909-1941* (Annapolis: Naval Institute Press, 2001), 98-98. The Japanese aviation industry had only two manufacturers Nakajima and Mitsubishi. In addition, the Army and Navy submitted separate designs to the manufactures but had little control over the contractors or the process.

¹⁰ Jeremy Black, *World War Two: A Military History* (New York: Routledge, 2006), 31-32.

¹¹ Weinberg, *A World at Arms*, 6 and 30. The Soviet Union defeated the Japanese in the Nomohan Incident in 1939 resulting in a neutrality treaty in 1941.

¹² Weinberg, *A World At Arms*, 634.

¹³ Gray, *The Leverage of Sea Power : The Strategic Advantage of Navies in War*, 242.

industrial power in opposing the Germans along the pivotal Eastern Front.

During their initial offensive in 1937, Japan gained control of many of the eastern ports in China and parts of the Yangtze River.¹⁴ They followed with Shanghai and Nanjing (Nanking) later in the year. By 1938, with a puppet government on Formosa, they controlled the straights of Taiwan and the major logistical hubs of China.¹⁵

Once ensconced in the country, the Japanese installed a Chinese-led puppet government over the regions they controlled. The fractious nature of Chinese politics, with the weak and autocratic Nationalists under Chiang Kai-shek, the stronger, but poorly supplied, communists under Mao, and numerous unallied war loads, both helped and hindered the Japanese. On the one hand, the Japanese were able to quickly exploit the situation and decimate the Chinese nationalists—to the delight of Mao and other rival factions.¹⁶ At the same time, trying to control such a vast region required numerous material resources and manpower. For Japan, Chinese resources proved hard to exploit while fighting a war at the same time.

Japan's aerial efforts proved counterproductive, logistically and strategically. As the Japanese took territory on the coast, the Nationalist government moved further inland, first to Hankow and then to Chungking.¹⁷ The only way to attack Chiang's government directly was through strategic bombing. By 1940, the Japanese routinely sent raids of fifty to ninety bombers to attack Chinese central cities.¹⁸ The effects were dubious at best. Despite turning Chungking to rubble, the Japanese raids served only to stiffen Chinese resolve. Much like the

¹⁴ Black, *World War Two*, 32.

¹⁵ Black, *World War Two*, 32.

¹⁶ Mao Tse Tung, *The Selected Works of Mao Tse Tung*, Second Edition ed., vol. II (Peking: People's Publishing House, 1965), 13. During the war, Mao chastised Chiang for trying to "parlay" with the ,

¹⁷ Peattie, *Sunburst*, 120.

¹⁸ Peattie, 121.

German attacks on London in 1940 and the Allied Combined Bomber Offensive (CBO) would show; populations could withstand brutal air attack and still fight. Douhetian aerial bombardment logic and the single LOC of the air had limits.

The vast expenditure of resources for the bombing campaign highlighted a weakness in Japan's vertical supply chain. Although the Japanese greatly expanded their aircraft production during the war against China, some 300 percent by 1941, they produced only 5,088 total, split between the Army and Navy, by 1941.¹⁹ By 1944, even though Japanese industry produced more than 28,000 aircraft, it was less than the 10 percent of the American aviation production.²⁰ Modern industrial air war was resource-intensive; and long before December 7, 1941, the Japanese lagged well behind their future competitor.

As part of their plan to horizontally expand their resources by conquest, while also denying LOCs to the Chinese, the Japanese looked southward. Emboldened by Germany's defeat of France and Britain in the West in 1940, Japan moved south. The Vichy government "agreed to the Japanese occupation [of French Indochina] without firing a shot."²¹ After their initial forays, the Japanese concluded, "that 41 percent of the outside supplies reaching Chiang came through the port of Haiphong in French Indochina, 31 percent on the Burma road."²² The Japanese then convinced the British, stung by Dunkirk and beginning a fight for survival in the skies overhead the British Isles, to close the India-Burma road.²³ Thus, by the summer of 1940, the Japanese extracted rice and

¹⁹ Richard J. Overy, *The Air War: 1939-1945* (Washington, DC: Potomac Books, 2005), 87.

²⁰ Overy, *The Air War*, 93.

²¹ Weinberg, *A World at Arms*, 254.

²² Weinberg, *A World at Arms*, 166.

²³ Weinberg, *A World at Arms*, 168.

rubber from French Indochina while also denying a critical LOC for the Chinese Nationalists.²⁴

This aggressive move into Southeast Asia put the Japanese on a collision course with the US; and resources literally fueled the feud. After the Japanese move southward, the US put a petroleum embargo on them in 1941, while also beginning further aid to China, which by the summer of 1941 formed a part of the Lend-Lease program.²⁵ Despite the gains the Japanese had made in China and to the South, keeping control of the empire drained as many resources as it gave them. Under the pretext of petroleum starvation, and looking further south to the Dutch East Indies, the Japanese attacked Pearl Harbor and consummated the global conflict. Unlike Germany, Japan, by maintaining a tenuous neutrality with her neighbor on the Pacific rim, managed to avoid pitting herself in a war of attrition against two greatest industrial powers of the period, the United States and the Soviet Union,. Nonetheless, she chose poorly, as the United States alone, even treating the Pacific as a second priority to Europe, had enough productive might and naval power to overcome an island empire that, like the South in the American Civil War, was “too dependent on water transportation.”²⁶

The War of LOCs: US versus Japan in China

Meanwhile, as Britain focused on Europe, it paid much less attention to the problem of Japan in the Pacific. As a result, the British gave scant notice to the supply line from the Allies to Chinese Nationalists through Burma.²⁷ Since the British treated the land communications route with only minor concern, they “insisted on operating [the Assam railway in Burma] like a minor branch of the

²⁴ Roger Annett, *Drop Zone Burma : Adventures in Allied Air Supply 1942-45* (Barnsley: Pen & Sword Aviation, 2008), xxi.

²⁵ Black, *World War Two*, 90.

²⁶ Ropp, *War in the Modern World*, 184.

²⁷ Weinberg, *A World at Arms*, 639.

Toonerville trolley.”²⁸ With token logistics support, and that only by air, the British held out with a small force in Burma designed to block any Japanese advance into India.²⁹ Despite British dalliance about the Burma supply route, it still provided over 30 percent of supplies to the Chinese Nationalists in 1940.³⁰

For the US, on the other hand, supplying the Chinese was both an effective way to fight the Japanese and hedge into what American entrepreneurs had always recognized as the largest market in the world. By 1942, with the US beginning the slog of island hopping towards the Japanese Islands, supplying China represented a way to fight the large Japanese Army on mainland China directly. Late in 1942, the United States Air Army Forces (USAAF) designed a supply route from Burma to China, over the Himalayas called the Hump.³¹ In the first year of operation, the US flew 13,000 Chinese soldiers to Burma for training under Army General Stilwell and then back into China to face the Japanese.³² Hump Operations eked along until 1944, when the US sent more airlift aircraft, and General William Tunner to improve operations. By August 1945, the Hump air route carried nearly ten times the amount delivered from the Burma Road into China. Tunner remarked, “The maximum amount of support carried over the Burma Road at its very peak of operation amounted to just six thousand net tons a month. Many of our thirteen bases in India were topping that figure, constantly and without fail.”³³ Given that the Hump airlift, although spectacular by the end of the war, could move only so many assets into China, the US decided to pursue a strategy of building up airpower logistics in China

²⁸ Weinberg, *A World at Arms*, 639.

²⁹ Annett, *Drop Zone Burma*, 30.

³⁰ Weinberg, *A World at Arms*, 166.

³¹ Annett, *Drop Zone Burma*, 30.

³² Annett, *Drop Zone Burma*, 30.

³³ William H. Tunner, *Over the Hump*, [1st ed. (New York: Duell, Sloan and Pearce, 1964), 130.

from which to challenge the Japanese home islands.³⁴ Although the US attempted to use the newest technology of the B-29 to strike Japan from China in 1945, all fuel and bomb tonnage had to be flown in over the Hump, an extremely inefficient operation.³⁵ Thus, much as the Germans learned on the Eastern Front and the Allies learned in Europe, an air LOC could supply the fight, but at great expense and without the staying power of sea or land communications.

The Chinese Endgame

In 1943, as the United States stepped up its island-hopping campaigns against the Japanese Army and its submarine campaigns against Japanese merchant shipping, the island empire increasingly relied on French Indochina and Burma to supply the Japanese Army deployed on the Chinese mainland.³⁶ From 1943 to August 1945, the Japanese held their own in Burma and stayed secure in French Indochina, while continuing to pursue control of most of the railways in Eastern China, thereby reducing the deleterious effects of US submarine attacks on their merchant shipping.³⁷ Although the Japanese still had the majority of their Army intact on the Chinese mainland, they could not compete with the logistics juggernaut of the United States. Nonetheless, the war of attrition for East Asia destroyed Chinese Nationalist resources, military forces, and political power, leading to the Chinese Communist takeover in 1949. This ended the eighteen-year war—the longest of any in World War II.

³⁴ Weinberg, *A World at Arms*, 639.

³⁵ Weinberg, *A World at Arms*, 858.

³⁶ Weinberg, *A World at Arms*, 391.

³⁷ Black, *World War Two*, 220-221; Weinberg, *A World at Arms*, 391.

The Second Anglo-German War

We shall fight on the beaches, we shall fight on the landing grounds, we shall fight in the fields and in the streets, we shall fight in the hills; we shall never surrender, and if, which I do not for a moment believe, this island or a large part of it were subjugated and starving, then our Empire beyond the seas, armed and guarded by the British Fleet, would carry on the struggle, until, in God's good time, the New World, with all its power and might, steps forth to the rescue and the liberation of the old.

Winston Churchill, 1940

The war in Western and Southern Europe, which spilled over into the Mediterranean and North Africa, was only a third as long as the one on the Asian mainland; but its intensity and implications for the Atlantic culture continue to haunt historians. With the *Blitzkrieg* invasion of Poland on September 1, 1939, Hitler placed Germany in direct confrontation with France and Britain. As with the fronts that followed Poland, Germany sought both sustenance for its war-machine and living space for its expanding population. In much the same way as the Japanese, the Germans had a need for a parasitic horizontal, or strategic, supply chain. Although their vertical integration would prove much more capable, resourceful, and creative than the Japanese supply chain, the Germans still had to surge outward to secure the resources they needed.

Given this need, in the post-Poland agreement with the Soviet Union, the Germans concentrated on petroleum and agriculture to feed its armed and industrialized state.³⁸ In exchange for German manufactured goods, the Germans secured agreements from the Soviets for oil deliveries and railway transit.³⁹ These agreements also had

³⁸ Weinberg, *A World at Arms*, 63.

³⁹ Weinberg, *A World at Arms*, 63.

logistics and supply repercussions in the Pacific. For example, the Germans hoped to secure rubber from Japan transshipped through the Soviet Union via now available rail lines.⁴⁰ The Germans never secured these agreements, but were able to receive some rubber shipments from Japan via sea-blockade-running vessels in the fall of 1940.⁴¹ Ultimately, scarce rubber quantities hampered German efforts to attack their once-Allied Soviets in the summer of 1941.⁴²

The German's search for autarky in resources, whether rubber, chemicals, or fuel, led them to develop innovative substitute technologies. In the case of rubber, Germany developed Buna, or synthetic rubber, to supplement their deficient stocks.⁴³ However, even with substitution, the German war machine required an ever-growing list of resources, especially as their enemies gained industrial capacity. Unlike World War I, Hitler would be able to take advantage of the portions of the Heartland seized during the Poland campaign at the beginning, rather than at the end of the war. The German state used Poland's resources not just for agricultural production, but also for industrial plant relocation.⁴⁴ Thus, much like the Japanese, the Germans projected power outward for horizontal integration of resources, rather than through treaty or economic agreement.

The Germans took *Blitzkrieg* west in May 1940. Reabsorbing command-and-control and firepower-coordination lessons from the Poland campaign, they quickly moved into Belgium, the Netherlands,

⁴⁰ Weinberg, *A World at Arms*, 82-83.

⁴¹ J.W.M. Chapman, *The Price of Admiralty: The War Diary of the German Naval Attache in Japan, 1939-1945*, vol. 1 (Glasgow: 1982), xxxiii.

⁴² R.J. Overy, "Transportation and Rearmament in the Third Reich," *The Historical Journal* 16, no. 2 (1973): 408. Overy describes the severe shortage in fuel and rubber for German mechanized forces. They were well behind in what was needed in 1939 and never caught up to the massive requirements of the Eastern Front.

⁴³ Adam Tooze, *The Wages of Destruction: The Making and Breaking of the Nazi Economy* (New York: Penguin Group, 2006), 227.

⁴⁴ Tooze, *The Wages of Destruction*, 445-446. Most infamous of these plants was Auschwitz, which became a concentration camp and a chemical factory for German fuel additives and Buna (synthetic rubber).

and France. In doing so, the Germans effectively used airpower as roving artillery for their ground forces. From a logistics perspective, they used rail transportation to mass troops on the border. Once the army was mobile, however, the Germans did not concern themselves greatly with railroad supply. Instead, they used the internal combustion engine, in the form of the truck, the tank, and the airplane to destroy, move, and supply with a flexibility steel rails could not match.

During the operation, the *Luftwaffe* also introduced a new maneuver element for infantry and re-supply: glider assault. Using eighty-eight paratroopers aboard eleven gliders, the Germans assaulted Fort Eben Emael, which Alistair Horne refers to as “the world’s strongest fort,” just five minutes before the larger armies began the Western invasion.⁴⁵ Fort Eben Emael, in Belgium, occupied a critical piece of land overlooking the Maastricht salient. The fort offered high ground, which could see well into Germany, and protected the three bridges across the River Meuse. Once the Germans captured Eben Emael, and its 700 soldiers, the Panzer divisions quickly streamed into Belgium.⁴⁶ Mitchell’s vision of air forces directly delivering armed forces to the battlefield was realized in the event.

The success of the Eben Emael raid led to massive programs for the Axis and the Allies to develop airborne and glider assault forces.⁴⁷ Unnoticed in the raid’s stunning success were the difficulties the German paratroopers faced as they held out for slow-moving, ground-based logistic support. Airborne assets delivered a striking blow quickly, but as a supply venue, they lacked the dependability and carrying capacity of sea and land communications. These deficiencies would haunt both the Axis and Allies in future operations.

⁴⁵ Alistair Horne, *To Lose a Battle : France 1940*, Rev. and updated. ed. (New York: Penguin Books, 1990), 268.

⁴⁶ Paul Witkowski, "Glider Assault on Eben Emael as an Archtype for the Future," *Infantry* 93, no. 2 (2004): 30-31.

⁴⁷ Witkowski, "Glider Assault," 32.

The speed and dynamism of Blitzkrieg in both the air and on land came at a logistical price. Only 15% of 103 divisions available for the German Western campaign were fully motorized.⁴⁸ As a result, the vast majority of the German infantry marched into battle, supplied with horse-drawn vehicles as their compatriots had been during the German Wars of Re-unification and World War I.⁴⁹ This same pattern would repeat itself on the Eastern Front the following year. Fast moving mechanized forces and airpower would move well ahead of their LOCs, supplemented with truck-borne or air logistics (as first shown at Eben Emael), and wait for the infantry to arrive.

As part of their fast-moving, highly successful operation, the German High Command freed the *Luftwaffe* to destroy the British Expeditionary Force (BEF) as it evacuated towards the port of Dunkirk. Through this operation, the Germans attempted to destroy the Sea-Land LOC connection critical to the BEF. However, according to Weinberg in *A World at Arms*, the home-based and supplied Royal Air Force (RAF) pummeled the *Luftwaffe* over the beaches, providing the British Navy and private vessels the freedom to move the troops back to England.⁵⁰ Others, such as Alistair Horne in *To Lose a Battle* and Van Creveld in *Supplying War*, suggest that the Germans simply had overextended their LOCs.⁵¹ In other words, the fast-moving German motorized divisions were in danger of outrunning their logistics.

Both interpretations revolve around LOCs. The RAF, with air superiority over the English channel, was able to extend onto the continent and halt the *Luftwaffe*'s attack on the BEF evacuation. At the

⁴⁸ Martin Van Creveld, *Command in War* (Cambridge, Mass.: Harvard University Press, 1985), 144. 16 of 103 Divisions.

⁴⁹ Van Creveld, *Supplying War*, 144.

⁵⁰ Weinberg, *A World At Arms*, 130-131.

⁵¹ Horne, *To Lose a Battle*, 562; Van Creveld, *Supplying War*, 146; Stephen Bungay, *The Most Dangerous Enemy* (London: Aurum, 2000), 31. Bungay adds another theory that "Hitler thought the ground in Belgium was bad tank country." Hitler wanted to conserve strength to finish the French and for his planned push East against the Soviet Union the following year.

same time, the overextended German armored division had to repair and resupply for their push to Paris. As a result, the Germans had to rely on the *Luftwaffe* to attempt to destroy the BEF at Dunkirk.⁵² In a theme repeated throughout the war on all sides, airpower was insufficient to destroy and control communications on its own. However, sea and land communications now required airpower for protection. In other words, a network that combined LOCs and combat power across air, land, and sea was necessary to secure victory.

Luckily for the Germans, lightning war gained them political victory in a short time period. When faced with a fast-moving opponent, the French and the BEF folded. When Allied air forces attempted to stop the advancing German armies and interdict their land communications, they were unsuccessful. The German army reached Paris on June 14, 1940 and had an armistice agreement by June 25, 1940.⁵³

As the Germans decided how to govern the West, Hitler planned for the East. True to their parasitic nature and responding to genuine needs, the Germans requisitioned all the railroad equipment they could in France and the low countries. In the Netherlands alone, the Germans took 55% of all locomotives, 96.5% of all freight cars, 82% of all passenger cars, and 72% of all electric trains for use internal to Germany and for the Eastern Front buildup.⁵⁴ The shortages in rubber and fuel meant that despite the previously mentioned *Blitzkrieg* mythology of highly mechanized armies, the war in the East “was to be a railway war, just as the conflicts of 1870 and 1914 had been railway wars.”⁵⁵

⁵² Williamson Murray, *Strategy for Defeat: The Luftwaffe, 1933-1945* (Maxwell: Air University Press, 1983), 48 and 59.

⁵³ Weinberg, *A World at Arms*, 141.

⁵⁴ Overy, “Transportation and Rearmament,” 392.

⁵⁵ Royal Institute of International Affairs, *Hitler's Europe* (Oxford: 1956), 258. Quoted in Overy, “Transportation and Rearmament,” 391. Overy shows how the automobile industry, in addition to German roads, was well behind the ability of the railroad to move the Army. Even the vaunted *Autobahn*, lacked the carrying capacity necessary to conduct any large-scale Army movement.

The Battle of Britain

The initial admixture of airpower and sea and land LOCs in the summer of 1940, would present a pattern repeated throughout the soon-to-be-global conflict. Airpower, the great destroyer, would become an arbiter of LOCs for both land and sea. One could secure neither sea-lanes, nor rail lines, or even highways without what Giulio Douhet and Julian Corbett might have together postulated as “local command of the air.” As the Second Anglo-German War shifted to the skies over Britain and then to the Atlantic, airpower would mature in this role.

After the Germans swept the BEF off Dunkirk, Hitler and his generals had a choice. With the British Army in disarray, the time to strike appeared ripe. However, getting across the channel would prove to be difficult—the *Kriegsmarine* adamantly dismissed the Germany Army’s plan for invasion as a suicide mission.⁵⁶ On the British side, the nation was in psychological panic. After Dunkirk, when the Japanese asked the British to close the Burma Road, a critical supply route for the Chinese, the British complied due to the greater threat in Europe and their own reluctance to support Chiang Kai-shek.⁵⁷

As the German High Command balked and Hitler dawdled, perhaps still hoping to frighten the British into an alliance that would preserve their empire and give him a free hand in Eastern Europe, resolve stiffened across the channel. Already pre-occupied the imperative to go east the next summer, the Germans left the fate of Britain the *Luftwaffe*. Steven Bungay in *The Most Dangerous Enemy* posits that Germany did this for two major reasons. First, it would allow Hitler to threaten invasion, without actually committing to a cross-channel operation, and hope the British would sue for peace. Second, it allowed Hitler to punish the British directly for standing in his way, a

⁵⁶ Bungay, *The Most Dangerous Enemy*, 112-113.

⁵⁷ Weinberg, *A World At Arms*, 168.

theme very popular in Germany at the time after Dunkirk.⁵⁸ In either case, the Battle of Britain would be the first time in history that one belligerent would try to influence a political outcome by another belligerent using airpower alone.

The Germans began the Battle of Britain against British shipping on July 10, 1940. In essence, the Germans turned their airpower advantage against the power of the British Navy and its commercial and military sea LOC. In the first three weeks, the *Luftwaffe* sent more than 40,000 tons to the bottom of the English Channel, in addition to sinking several British cruisers and naval vessels.⁵⁹ These operations forced the British to direct shipping to the west coast of the island and then move goods by rail.⁶⁰ In these initial operations, the *Luftwaffe* used airpower to try to clear a Sea LOC for the *Kriegsmarine*.⁶¹ In counter-bombing moves, RAF Bomber Command struck possible Operation Sea Lion invasion forces and equipment.⁶²

The channel operations were inconclusive and showed both sides only how resilient the other was, therefore the *Luftwaffe* shifted its strategy to air superiority. Throughout the fall, the *Luftwaffe* attacked airfields, RAF fighter command, and eventually London.⁶³ However, the British never surrendered and the bombings on London only served to strengthen British resolve.

The *Luftwaffe* suffered 873 aircraft losses, without gaining air superiority, a political capitulation, or even an accommodation on the

⁵⁸ Bungay, *The Most Dangerous Enemy*, 33.

⁵⁹ J. Rikard, "Battle of Britain, 10 July -- 31 October 1940" http://www.historyofwar.org/articles/battle_of_britain.html (accessed 3 April 2012).

⁶⁰ Len Deighton, *Fighter: The True Story of the Battle of Britain* (Ann Arbor: Cape, 1977), 139. Deighton shows how the issue of shipping going by rail split the British Admiralty and the RAF. RAF Air Marshall Dowding resisting sending more RAF planes over the channel to protect shipping when the convoys could be redirected to the West coast and moved by rail.

⁶¹ Bungay, *The Most Dangerous Enemy*, 149.

⁶² Bungay, *The Most Dangerous Enemy*, 92. The British flew 9,180 bomber sorties against German targets—mostly coastal ports and possible Operation Sea Lion invasion forces.

⁶³ Bungay, *The Most Dangerous Enemy*, 312.

part of the British.⁶⁴ Airpower was not yet mature enough to bully a resourceful government or resupply a beleaguered army. It could provide the decisive margin of difference in nearly any operation and was often necessary to secure victory, yet it was insufficient to win on its own. Both Mitchell and Douhet were incorrect; airpower could not yet unilaterally achieve victory. In addition, Naval Forces could no longer move without aircraft both to aid in the projection of power and to defend them from other air and sea forces. On land, airpower could secure flanks, interdict enemy supplies, deliver airborne infantry assault on point objectives, and shortly resupply small forces. Airpower, by 1940, was well on its way to becoming the great arbiter of land and sea LOCs in what was shaping up to be a war of industry and movement.

The Greatest of All LOC Wars: The Second Battle of the Atlantic

With France secure in June of 1940, the German High Command moved its submarine operations to Bordeaux. For the first time in history, Germany had free range into the Atlantic without the requirement of British permission. Under Mahan's rubric, French, Danish, and Norwegian ports added missing dimension to Germany's sea power characteristics—geographical position and physical conformation.⁶⁵ With the full understanding, that rolling the German Army into Poland would bring Britain and France against his nation, Hitler released several smaller battleships and more than a dozen submarines into the Atlantic before hostilities began on the Western Front in May 1940. Understanding the strength of the British fleet, Hitler sought to get ahead in the war against Allied sea LOCs. Although less than two dozen in number, these vessels made a psychological impact immediately by sinking the battleship *Royal Oak* in port at Scapa

⁶⁴ Bungay, *The Most Dangerous Enemy*, 371.

⁶⁵ John B. Hattendorf, ed. *Mahan on Naval Strategy: Selections from the Writings of Rear Admiral Alfred Thayer Mahan* (Annapolis: Naval Institute Press, 1991), 31 and 37. Mahan considered French geography and physical conformation inferior to the British. However, his methodology was based on ports for ships-of-the-line and not the submarines the Germans used.

Flow in October 1939.⁶⁶ The *Graf Spee*, a German “pocket battleship,” had spectacular success in the fall of 1939, causing the British and French to send several squadrons of ships to hunt and eventually force the Germans to scuttle the craft in the South Atlantic.⁶⁷

As the naval campaign wore into 1940, initial German naval success coupled with German air missions into English territory, hemmed in British commercial shipping.⁶⁸ For the first time in four centuries, British shipping in the channel was contested. During the 1939-1940 time-period, the German Navy used mostly surface ships, such as the *Graf Spee* and the famed *Bismarck*, to attack Allied shipping.⁶⁹ In addition, the Germans sent FW 200 Condor aircraft, converted airliners, from France to Norway on reconnaissance missions. These aircraft had initial success against lone ships in the North Sea from 1940-1941, gaining “a degree of success far beyond their limited numbers or the FW 200s intrinsic quality as a bomber.”⁷⁰ By the end of the war, the FW 200 was responsible for 13.4% of all Allied ships sunk in the Atlantic.⁷¹ As with the Battle of Britain, those surface ships that moved without airpower support, or anti-aircraft weapons, increasingly came under attack.

When the Germans ramped up their sea campaign in mid-1940, Allied success in blockading German surface ships and sinking others led the *Kriegsmarine* to turn to its submarines. The *Kriegsmarine* U-Boats used famous “wolf pack” attacks to identify and surround convoys. Using the same improved radio technology, the ability to transmit voice, which *Blitzkrieg* required, the German navy deployed U-

⁶⁶ Weinberg, *World at Arms*, 70.

⁶⁷ Weinberg, *World at Arms*, 70.

⁶⁸ Marc Milner, “The Battle That Had to Be Won,” *Naval History* 22, no. 3. (2008), under “WWII’s Greatest Battle,” <http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=31947739&site=ehost-live&scope=site>.

⁶⁹ Milner, “The Battle,” under “Early Menaces to Allied Shipping.”

⁷⁰ Alfred Price, *The Luftwaffe Data Book* (Pennsylvania: Stackpole Books, 1997), 182.

⁷¹ Black, *World War Two*, 65.

boats in perpendicular lines.⁷² When one U-boat found a convoy, it would send radio messages and direction-finding signals upon which other U-Boats would converge.⁷³ Once in position, and usually at night, the U-Boats would unleash their attack and slip away. The U-boats had spectacular success in late 1940 and into mid-1941, sinking roughly 300,000 tons of merchant shipping on average, which was at or above the tonnage Britain needed.⁷⁴

On the Allied side, the British had not forgotten the convoy lessons of World War I, but rather technology had changed the sea LOCs. The British understood submarines to be most effective as ships came into and out of port. Therefore, they placed more emphasis on the close-in waters. Once the transport ships were far out to sea, the odds seemed much lower that a submarine could locate shipping in a big ocean.⁷⁵ In addition, the British did not provide much air support to convoys, since they believed that new sonar technology and World War I convoy tactics would prevail.⁷⁶ However, the “wolf pack” tactics, coupled with initial FW 200 reconnaissance and the radio, allowed U-Boats to coordinate in the far expanses of the Atlantic.⁷⁷

In the spring of 1941, the greatest LOC war began in earnest with the signing of the American Lend-Lease program. With this document, signed in April, the US agreed to supply Britain and eventually Free-France, China, and, with the German invasion in June 1941, the Soviet Union.⁷⁸ Lend-Lease solidified two things. First, the Americans, if they entered the war, would be on the side of the Allies. Second, the great

⁷² Milner, “The Battle,” under “The Wolf Pack: Keys to Success.”

⁷³ Milner, “The Battle,” under “The Wolf Pack: Keys to Success.”

⁷⁴ John Buckley, “Air Power and the Battle of the Atlantic: 1939-1945,” *Journal of Contemporary History* 28, no. 1 (1993): 145.

⁷⁵ Milner, “The Battle,” under “The Wolf Pack: Keys to Success.”

⁷⁶ Buckley, “Air Power and the Battle of the Atlantic,” 143.

⁷⁷ Price, *The Luftwaffe Data Book*, 182 and Milner, “The Battle,” under “The Wolf Pack: Keys to Success.”

⁷⁸ Richard Holmes and others, *The Oxford Companion to Military History* (Oxford ; New York: Oxford University Press, 2001), 552-553.

heartland of the war shifted from Mackinder's Eurasia to North America. The US was now the great horizontal integrator of supply for the Allied cause.

With Germany's invasion into the Soviet Union, the Battle of the Atlantic took on new meaning. Under Lend-Lease, American supplies were bound for Russia to stop the German land invasion.⁷⁹ Now supplies would flow from America through the Atlantic, into the Arctic, over the old Heartland and into the Soviet war machine. Whether American Lend-Lease aid was bound for the Soviet Union or Britain, the US Navy now had to protect the shipping. When the Japanese attacked Pearl Harbor on December 7, 1941, and the Germans declared war on the US four days later, the US Navy formally entered the Battle of the Atlantic.⁸⁰

As the German Army stalled outside of Moscow in the winter of 1941-1942, *Kriegsmarine* U-Boats continued their success against the Allies. With the US formally in the war, the Germans attacked American shipping off the coast. Hitler ordered the first U-Boats to speed towards the US one day after Germany declared war.⁸¹ Even though the US Navy had already begun convoy operations for Lend-Lease shipments in 1941, the US Navy was ill prepared for the demands of war in 1942.⁸² The Germans sunk nearly 100,000 tons of American shipping in February 1942, and more than 150,000 tons in March 1942.⁸³

In the first stages of the Battle of the Atlantic, the British did not direct enough aircraft for anti-submarine operations. This was partly due to RAF Bomber Command's insistence that all bomber aircraft be

⁷⁹ Colin Gray, *The Leverage of Sea Power: The Strategic Advantage of Navies in War* (New York: Free Press, 1992), 242.

⁸⁰ Milner, "The Battle," under "America Gradually Enters the Battle." With beginning of the Lend-Lease in mid-1941, the US Navy began escorting merchant convoys.

⁸¹ Stephen Wentworth Roskill, *The War at Sea, 1939-1945*, 3 vols., History of the Second World War United Kingdom Military Series, vol. 2 (London,: H.M. Stationery Off., 1954), 96.

⁸² Black, *World War Two*, 113.

⁸³ Roskill, *The War at Sea*, 96.

used for bombing missions against the Third Reich and to the British predilection to organize shipping convoy systems along defensive instead of offensive lines.⁸⁴ Despite the demonstrations of the power of aircraft against ships, which Brigadier General Mitchell had demonstrated in the 1920s, the US Navy and Army Air Corps transferred few of these lessons to U-boat operations in 1942. Rather than concentrate their airpower and naval power in convoys, “the Navy established a series of patrols along designated routes and tried to move dispersed shipping along them. By 1 April, 80 small ships and some 160 aircraft between Maine and Florida were engaged in these operations...Routine patrols and dispersed shipping allowed U-boats to operate at leisure, confident that they would not be interrupted and assured that another target would come along like clockwork.”⁸⁵ As a result, U-Boats sank 115 ships in May of 1942, and 122 in June off the American coast.⁸⁶ Little wonder German U-boat skippers referred to this as “the happy time.”⁸⁷

The Americans adjusted their convoy procedures slowly and by June 1942, chased the U-Boats out into the Atlantic.⁸⁸ As the British used their airpower more effectively at the same time, through coordinated missions and consolidated control, they drove the U-boats into an “Atlantic gap” beyond the range of shore-based planes.⁸⁹ Out in the open ocean, the Allied addition of seaborne airpower through the use of “jump” carriers, and the subsequent dwindling of German FW 200s (due to Allied aerial success and airlift demands on the Eastern Front) led to dwindling German U-Boat effectiveness.⁹⁰ Allied success was due

⁸⁴ Buckley, “Air Power,” 145.

⁸⁵ Milner, “The Battle,” under “Carnage Along the East Coast.”

⁸⁶ Milner, “The Battle,” under “Carnage Along the East Coast.”

⁸⁷ Jeremy Isaacs and others, “The World at War. [No.] 10, Wolf Pack--U-Boats in the Atlantic, 1939-1944,” (Great Britain: Thames Television, 1973).

⁸⁸ Black, *World War Two*, 113.

⁸⁹ Buckley, “Air Power,” 155.

⁹⁰ Roskill, *The War at Sea*, 436. The Germans sunk 5.4 million tons of Allied shipping in 1942 and 1.4 million in the first six months of 1943. However, they would never again reach the apogee of June 1942 when they sunk 623,545 tons of Allied shipping.

not only to the airplane's ability chase U-Boats under the surface, but also to the full integration of the airplane, the radio, and code breaking to secure U-Boat locations.⁹¹ Thus, "by the end of 1943 U-boats were living a fugitive existence in the Atlantic, operating independently and trying not to reveal their presence by transiting radio signals...they were never again a threat to Allied strategy."⁹²

The Battle of the Atlantic was a triumph for the Allies. All told, they sunk 536 German U-Boats, 290 of them by air.⁹³ As they gained control of the Atlantic, the Allies furthered their blockade against Germany and German controlled French ports. When the Germans had their initial success in the Atlantic from 1940-1942, their blockade running was also more successful. The Germans were able to deliver 75% of their cargo past the blockade up until June 1942.⁹⁴ In addition to receiving cargo through the blockade, the Germans were also able to deliver more than 32,500 tons of cargo, in the form of engine, engine parts, and chemical products to Japan between September 1941 and June 1942.⁹⁵ By the next year, however only 26% of blockade-runners into Germany made it through the Allied cordon.⁹⁶

The air superiority that gained the Allies control of the sea, also gave them control of the air. In turn, the Allies built a massive air line of communication, comprising airlift and combat aircraft from North America to Europe. Between 1942 and 1945, the US flew more than 130,000 aircraft—fighter, bomber, and transport—over Newfoundland,

⁹¹ Buckley, "Air Power," 149. According to Buckley, "during the Second World War, U-boats were not true submarines but could best be described as submersible torpedo-boats. They had to surface for a certain number of hours each day to recharge their batteries, which provided underwater power. U-boats dived to avoid detection and did not travel underwater as a matter of course."

⁹² Milner, "The Battle," under "The Tide of Battle Turns."

⁹³ Buckley, "Air Power," 143.

⁹⁴ Roskill, *The War at Sea*, 482.

⁹⁵ Roskill, *The War at Sea*, 483-484.

⁹⁶ Roskill, *The War at Sea*, 483.

through Iceland, and on to Great Britain.⁹⁷ They also turned the Atlantic air transportation route into the most robust airline in the world, carrying tens of thousands of passengers each month from the US to Europe.⁹⁸ In essence, the air LOC enabled both logistics and combat power for the eventual defeat of Germany, all without any contest from German air power.

The Allied success at sea changed the German raw materials equation drastically. For example, in 1938, Germany imported 77,000 tons of Rubber; by 1943, it was only 8,000 tons.⁹⁹ Due to the demand that modern industrial machines—notably aircraft and wheeled vehicles placed on rubber—the Germans ramped up their internal manufacturing of artificial rubber, Buna, from 6,000 tons per year in 1938, to 120,000 tons per year in 1943.¹⁰⁰ Although the German total output of rubber increased greatly, Buna required further drains on Germany's limited petroleum supply. In other words, the Germans had to tighten up their vertical supply chain due to the lack of horizontal integration of raw materials.

During the Battle of the Atlantic, the Allies were able to use their sea superiority to connect the war in Europe to the American Heartland that produced 32% of all world-manufactured goods as the war began.¹⁰¹ In turn, the Americans provided over 5,777 cargo ships and tanker vessels to the war.¹⁰² Through the massive sea LOC, the Americans provided more than half of all vehicles the Red Army used during the war, numbering some 427,000.¹⁰³ The sea communications route to the Soviet Union took place not only through the Atlantic, but

⁹⁷ Wesley Frank Craven and others, *The Army Air Forces in World War II*, 7 vols., vol. VII (Washington, D.C.: Office of Air Force History : For sale by the Supt. of Docs., U.S. G.P.O., 1983), 18.

⁹⁸ Craven, *The Army Air Forces*, 18.

⁹⁹ Tooze, *The Wages of Destruction*, 228.

¹⁰⁰ Tooze, *The Wages of Destruction*, 228.

¹⁰¹ Overy, *The Air War: 1939-1945*, 151.

¹⁰² Gray, *The Leverage of Sea Power*, 240.

¹⁰³ Gray, *The Leverage of Sea Power*, 240.

also through the Pacific. Forty-seven percent of all supplies shipped to the Soviet Union from the United States went through the Pacific, while 25% went via the Atlantic and into Soviet arctic ports.¹⁰⁴

To create and run their sea communications, the Allies harnessed the internal combustion engine, the radio, and took advantage of technologies such as code breaking and radio detection and ranging (RADAR) to win the battle of the Atlantic. While the Germans used these same technologies for their initial success, without a corresponding use of Airpower to protect their sea communications, they were doomed to defeat. Given the strategic imperative to win in the East in 1941-1943, however, Germany had no choice but to keep most of the *Luftwaffe* Easton on that front.

The Allies linked their weapons, transportation, internal manufacturing abilities, and external staging basis for troops and equipment into a networked sea, land, and air LOC that provided both support to the Soviet Union and began the buildup for the 1944 invasion of the continent.¹⁰⁵ In the same month, June 1942, that US naval air forces decisively beat the Japanese at Midway and began to establish a sea LOC in the Pacific, Allied air forces began to turn the war in the Atlantic, creating the sea communications that would supply the Allies' European endeavors for the next three years. As the Allied sea LOC began its first big test for the movement of American forces to North Africa in the fall of 1942, the German land communications reached their full extension at Stalingrad. When the Americans and British landed on November 8, 1942 to begin Operation Torch in North Africa, at the behest of Soviet Union, which needed dire relief as Stalingrad

¹⁰⁴ Gray, *The Leverage of Sea Power*, 242.

¹⁰⁵ Weinberg, *A World at Arms*, 359. The importance the Allies placed on logistics was shown through their naming of the operation—*Bolero*—that was to buildup forces in England. Logistics was far more than a supporting function; in many ways, it was the bones of strategy in the war. [Such ruminating belongs in the text, perhaps the conclusion, rather than a footnote.]

reached its climax, the logistical fates of Germany and Japan were sealed.

Smaller Theater and Greater LOCs

The fight in North Africa pitted Allied dominance at sea against the combined air-land tactics of Field Marshall Rommel and his forces. Since the Germans were in the fight of the war at Stalingrad in the fall of 1942, Hitler devoted only enough airpower to keep the campaign afloat.¹⁰⁶ With the Allies in control of the Mediterranean it was only time before the Germans fell in Tunisia.¹⁰⁷ For the Americans, Operation Torch was a lesson in both combat and logistics.¹⁰⁸

Once the Allies had North Africa, they focused air efforts on softening up Sicily for the July 1943 invasion.¹⁰⁹ They also turned their bombing efforts towards the Third Reich itself. Even during the brief phony war period, Britain and France had wanted to cut German oil imports to include plans to strike Soviet oilfields in the Caucasus.¹¹⁰ By August 1943, North Africa offered a perch from which to strike the refineries at Ploesti, under German control from her reluctant ally, Romania. As with the raids that characterized many of the CBO missions that were just beginning en masse over Germany, fuel, was the target.¹¹¹ The 177-plane raid suffered from bad navigation and determined Axis anti-aircraft defenses. As a result, the Americans lost an unsustainable 41 aircraft to enemy action.¹¹² Although the raid was

¹⁰⁶ Overy, *The Air War*, 69.

¹⁰⁷ Rick Atkinson, *An Army at Dawn : The War in North Africa, 1942-1943*, 1st ed., The Liberation Trilogy (New York: Henry Holt & Co., 2002), 526. The Germans surrendered in May 1943.

¹⁰⁸ Overy, *The Air War*, 69. The improper coordination of air and ground elements—ultimately led to the creation of separate air groups for centralized control.

¹⁰⁹ Johannes Steinhoff, *Messerschmitts over Sicily : Diary of a Luftwaffe Fighter Commander*, 1st ed., Stackpole Military History Series (Mechanicsburg, PA: Stackpole Books, 2004), 127.

¹¹⁰ Weinberg, *A World at Arms*, 73.

¹¹¹ Murray, *Strategy for Defeat*, 174.

¹¹² Murray, *Strategy for Defeat*, 174.

a failure, it showed how airpower could influence lines of communication indirectly by depriving them of essential fuel. As with many theaters during the war, the Ploesti raid showed how an operation in one area could support or put pressure on an LOC in another. Airpower, for example, not only protected Allied sea communications in the Atlantic, the Allies also used it to strike at fuel production and storage, which then in turn affected land communications in Germany, as well as the Reich's further ability secure its own communications and harass those of the Allies by air.

The Combined Bomber Offensive: Killing the Great Arbiter

The CBO used RAF and USAAF bomber crews to attack German cities and industry. While the RAF bombed at night, focusing more on populated areas, the USAAF bombed during the day and focused more on industry. The American bombing concepts were based on the Air Corps Tactical School theories of the 1930s. These ideas coalesced into a part-Douhetian, part-Mitchellian concept called the Industrial web theory.¹¹³ American bombing advocates believed that industrial economies had intricate webs of relationships and by hitting key parts of the web (e.g. oil production, chemical production, etc...) the entire economy would unravel.¹¹⁴ Thus, the industrial webbers staked their claim on the disaggregation of production—a key component in the vertical integration of a nation's supply chain.

When the industrial web theory met reality over the skies of Germany, the results were initially disastrous. Plagued by a lack of long-range escort and mature bombing tactics, the Americans suffered tremendous losses.¹¹⁵ During the Regensburg / Schweinfurt raids in the fall of 1943, designed to attack German ball bearing facilities, the USAAF lost 60 bombers, 10% of the total available, and nearly 18% of

¹¹³ Biddle, 291.

¹¹⁴ Biddle, *Rhetoric and Reality*, 291.

¹¹⁵ Murray, *Strategy for Defeat*, 173.

USAAF aircrews.¹¹⁶ As aircraft technology improved, most notably the drop-tanks for P-51 fighter escorts, the Americans could push further into the Third Reich with fewer losses.¹¹⁷ Thus, in some ways, the struggles the US had with bomber escorts mirrored the same lessons the US learned about sea-convoy escort in the first half of 1942. While protecting the convoy was important, being able to integrate technologies to destroy German offensive power was more important.

While the effectiveness of the CBO on stopping the German economy are still debated today, the bombing campaign effectively destroyed a potential arbiter—the German *Luftwaffe*. Since 1939 in the West, over Britain, and into the Soviet Union, the Germans had relied on the airplane to provide combat power, give airborne forces mobility, and perform critical re-supply. In July of 1943, the *Luftwaffe* provided more than 1400 aircraft in support of the *Wehrmacht* at Kursk.¹¹⁸ This was the last large usage of the *Luftwaffe* on the Eastern Front. With the CBO in full force by early 1944, Hitler had no choice but to hold back aircraft to protect the homeland.¹¹⁹

In defending against the CBO, the *Luftwaffe* paid a high price. As the bombing offensive ramped up in July and August 1943, the *Luftwaffe* lost 619 aircraft in those two months alone.¹²⁰ Although German fighter production actually increased from 15,409 combat aircraft in 1942 to 39,807 aircraft in 1944, the pilot losses were not so easily replaced.¹²¹ .¹²² By early 1944, the Germans lost 1,277 additional aircraft to combat and 1,328 to training accidents, a reflection of growing Allied air dominance and an acute shortage of trained *Luftwaffe*

¹¹⁶ Murray, *Strategy for Defeat*, 173.

¹¹⁷ Murray, *Strategy for Defeat*, 172.

¹¹⁸ Weinberg, *A World at Arms*, 602.

¹¹⁹ Weinberg, *A World at Arms*, 602.

¹²⁰ Murray, *Strategy for Defeat*, 181-182. The *Luftwaffe* lost 335 aircraft in July and 284 in August.

¹²¹ Overy, *The Air War*, 77. Murray, *Strategy for Defeat*, 181.

¹²² Murray, *Strategy for Defeat*, 182.

pilots.¹²³ By the time the Allies began the invasion of Normandy in 1944, the CBO had already assured the Allies had air superiority over the battlefield.

D-Day to Berlin: The Great Western Heartland Prevails

The Eastern Front always consumed the greatest amount of German military force. By the end of 1943, Germany had 2,800,000 troops in the East, and 2,440,000 in the West.¹²⁴ While the Allies fought the *Luftwaffe* in the air and the *Kriegsmarine* on and under the sea, the Soviet Union did the bulk of the land fighting. June 6, 1944 changed the equation.

Unlike the experience of the British Expeditionary Force during the First World War, the Allies would not be going ashore into friendly territory. As a result, the logistical needs were much greater. First, the Allies would need to assure that the Germans did not flood the transportation networks leading to Normandy. If the areas were impassable, the Germans could trap the Allies without room to maneuver. Second, the Allies would have to transfer more than 130,000 men and thousands of wheeled vehicles and artillery pieces from deep water to the shore.¹²⁵ Finally, the Allies needed to deny the Germans' the ability to reinforce the landing-area defenses through their usually efficient rail and road networks.

In order to control the bridges and roads and prevent their flooding, the Allies used airborne troops. The USAAF Troop Transport command used 1,000 C-47s to drop the 82nd and 101st Airborne divisions.¹²⁶ Much like German experiences with airdrop operations earlier in the war, the Allied operation achieved surprise. The airborne assault confused the Germans and allowed the Allies to hold the key

¹²³ Weinberg, *A World at Arms*, 633.

¹²⁴ Gray, *The Leverage of Sea Power*, 242.

¹²⁵ Thomas Alexander Hughes, *Over Lord : General Pete Quesada and the Triumph of Tactical Air Power in World War II* (New York: Free Press, 1995), 137.

¹²⁶ Hughes, *Over Lord*, 137.

transportation nodes inland from the beaches.¹²⁷ However, like earlier German experiences on the Western Front, the airborne operations proved difficult to coordinate once opposing fire disrupted aircraft flight patterns (spreading the drop zone area for miles around Normandy), and getting the airborne troops into a coordinated fighting cohort proved impossible.¹²⁸

In order to bring forces ashore the Allies built “two artificial harbors, called ‘Mulberries’, on the French coast.”¹²⁹ Once the beaches were secure and the Allies had moved out of the Normandy area, they would search for larger ports to bring more equipment ashore. The logistical difficulties of securing the mulberries while also fighting ashore required that the Allies stop any German reserves rushing to Normandy. Interdiction of rail lines was key to this effort.

Air vs. Rail: The Trains Do Not Run on Time

Since the German wars of reunification, the Prussians and then the German state had relied upon the rails to provide speed to the front. They also used trains deftly in World War 1 to transfer troops between fronts as needed. In addition, the Germans used trains to move their massive forces to the East before the push into the Soviet Union. In Mackinder’s Heartland, the train was the key to German power.

As the Allies planned for the D-Day invasion, they had to ensure that the German rail network did not run on time. Even as far back as February 1944, during “Big Week,” Allied airpower struck not only the *Luftwaffe*, but also German Land LOCs.¹³⁰ In the days leading up to June 6, 1944, the Allied command placed nearly 13,000 aircraft in support of D-Day.¹³¹ The key targets preceding the invasion were the

¹²⁷ Black, *World War Two*, 170.

¹²⁸ Black, *World War Two*, 170.

¹²⁹ Weinberg, *A World at Arms*, 681.

¹³⁰ Overy, *The Air War*, 76.

¹³¹ Hughes, *Over Lord*, 182.

rail and road networks in Western Europe that led to Normandy.¹³² After the precarious success of the initial landings at Omaha Beach, the US in particular shifted its air assets to interdiction targets—specifically railroads. The results were devastating, as Thomas Hughes states in *Over Lord: General Pete Quesada and the Triumph of Tactical Air Power in World War II*, “the Eighth (USAAF Eighth Air Force)...flew no less than 5,900 bomber sorties and dropped over 14,000 tons of bombs in direct support of land operations. In total they struck at fifty-eight marshaling yards, thirty-eight bridges, twenty-two trains, and nine convoys.”¹³³ These operations crushed the Germans’ ability to reinforce the Cotentin Peninsula. Without the use of rail and limited road mobility, the Germans moved “at a pace slower than that of a typical American Civil War march some eighty years earlier.”¹³⁴

The Red Ball Express and Arnhem: Sea-Land-Air Logistic Networks

Since the Allies relied on a tenuous sea-land LOC from the ships over the mulberries to the beaches, they had to secure other major regional ports to receive the greater amount of men and material necessary for invasion.¹³⁵ The Germans wrecked the large port at Cherbourg and securing the region around Antwerp proved arduous for the Allies.¹³⁶ As a result, when they finally broke out of the Normandy area in late July 1944, the Allies’ supply lines stretched thin.¹³⁷

During the quick rout of German forces in central and eastern France, the Allies faced nearly the same dilemma as the Germans had in 1940—their combat power (aircraft and mechanized forces) out ran their communications. The US set up the famous Red Ball Express, a wartime “one-way truck delivery procedure” to attempt to keep up with

¹³² Weinberg, *A World at Arms*, 663.

¹³³ Hughes, *Over Lord*, 149.

¹³⁴ Hughes, *Over Lord*, 150.

¹³⁵ Weinberg, *A World at Arms*, 681.

¹³⁶ Black, *World War Two*, 177.

¹³⁷ Black, *World War Two*, 174.

the combat elements.¹³⁸ However, even the special procedures for the Red Ball Express ran into the same difficulties the Germans faced in World War I and both 1940 in the West and 1941 in the East, with wartime commanders taking supply trucks bound for other units.¹³⁹ Luckily for the Allies, they controlled the skies and the *Luftwaffe* was never a significant threat to their Sea-Land LOC.

In order to increase their supply throughput from the sea, the Allies needed to secure the areas west of the port of Antwerp. Even though the British captured Antwerp on September 4, 1944, the Germans still controlled the region directly to the west called the Scheldt Estuary.¹⁴⁰ In order to secure this region and to satisfy the British operational desire for a move into the German Ruhr River valley, Eisenhower approved Operation Market Garden.

Market Garden represented the largest airborne mission of the war. The Allies used over 1800 aircraft to airdrop more than 20,000 troops and deliver 20,000 more by glider.¹⁴¹ After the first day of airdrop on September 17, 1944, the mission seemed a success, with Allied airpower covering the airdrop, and the “airborne commanders were unanimous and fervent in their praise of the accurate and efficient delivery of their troops.”¹⁴² By the next day, however, the airborne troops began to run short of supplies. The thin Allied supply lines, even with Red Ball Express-type tactics, could not give the forces the support they needed.¹⁴³ As a result, the Allies attempted aerial resupply using both troop transports and converted bombers. Although the converted

¹³⁸ Weinberg, *A World at Arms*, 699.

¹³⁹ Henry Effingham Eccles, *Logistics in the National Defense*, [1st ed. (Harrisburg, Pa.: Stackpole Co., 1959), 191. Van Creveld, *Supplying War*, 126-127. Van Creveld observes that during World War 1, “field commanders were tempted to ‘hijack’ the [supply] trucks and use them as rolling magazines.”

¹⁴⁰ Black, *World War Two*, 177.

¹⁴¹ John Cushman Warren, *Airborne Operations in World War II, European Theater*, Usaf Historical Studies, (Maxwell Air Force Base, Ala.: USAF Historical Division, Research Studies Institute, Air University, 1956), 226-227.

¹⁴² Warren, *Airborne Operations*, 115.

¹⁴³ Weinberg, *A World at Arms*, 701.

bombers dropped 258 tons on D-Day plus two, it was a fraction of what the ground troops needed.¹⁴⁴ Weather also played a factor as the Allies suspended follow-on resupply and troop airdrops for days.¹⁴⁵

Without adequate an air-to-ground LOC, the Allies lost the battle.¹⁴⁶ Much as the Germans had learned two winters before at Stalingrad, aerial resupply could get there fast, but not with much, thus violating Civil War General Nathan Bedford Forrest's first dictum of war: "to be fustest with the mostest."¹⁴⁷ Beyond the local conditions however, the inability of the Allies to secure and begin port operations from the sea, led them to failure. Proper networking of LOCs—across all domains was critical to success.

Battle of the Bulge to the End

The Battle of the Bulge represented a critical test for the Germans and the Allies, and logistics shaped both the strategic rationale and operational outcome for the battle. Since the Germans stopped the airborne operations into the Netherlands, the Allies had to regroup and slow their mobility-focused operations after the breakout from Normandy.¹⁴⁸ The German Army still had much fight left—as both Market Garden and the American experience in Lorraine, France proved.¹⁴⁹

When the Germans counter attacked into the Allied lines on 16 December 1944, the American and British LOCs were at their limit.¹⁵⁰ The German goal was to push the Allies back and reclaim the port of Antwerp with its rich source of Allied supplies.¹⁵¹ Antwerp was also essential for the forthcoming Allied push into Germany, since it

¹⁴⁴ Warren, *Airborne Operations*, 124.

¹⁴⁵ Warren, *Airborne Operations*, 149.

¹⁴⁶ Warren, *Airborne Operations*, 149.

¹⁴⁷ Ropp, *War in the Modern World*, 12.

¹⁴⁸ Black, *World War Two*, 177-178.

¹⁴⁹ Weinberg, *A World at Arms*, 702.

¹⁵⁰ Black, *World War Two*, 178.

¹⁵¹ Black, *World War Two*, 178.

represented a dramatic shortening of communications *vis-a-vis* the French ports under refurbishment. In order to avoid the airpower the Allies could bring to bear; Hitler ordered the attack during bad weather.¹⁵² The Germans overwhelmed the American front lines and pushed them as far back as St. Vith and Bastogne, still some one hundred miles from Antwerp.¹⁵³ Much like their operations in 1940, the Germans relied on the capture of enemy supplies and thus lacked sustaining power for their communications.¹⁵⁴

Despite the initial surprise, the Allies halted the German advance. As the weather cleared, airpower once again hammered the German lines. In addition, the Allied land LOCs were at the time sufficiently fed from the larger ports at Cherbourg and Antwerp to bring men and material to the fight.¹⁵⁵ By 1945, the Great Western Heartland had a secure sea-and LOC protected by airpower and supplied Germany's Eastern foe from US factories via two oceans. Although much hard fighting remained, logistically and strategically, the Third Reich was finished. At the same time, as US Naval presence choked off the home islands, and while the USAAF continued their heavy resupply of the Chinese, Japan awaited the same fate.

The Great Patriotic War

The number of [German] troops involved, almost three and a half million, was more than anything experienced before and in some ways since...this enormous mass, with its hundreds of thousands of horses and vehicles, had to be marched and supported while marching, towards objectives, which north to south, lay 600, 700, and 900 miles away from the base of departure.

Martin Van Creveld, *Supplying War*

Hitler had a fascination with cars. The National Socialist movement highlighted the new Autobahn and the Volkswagen as

¹⁵² Black, *World War Two*, 177.

¹⁵³ Weinberg, *A World at Arms*, 766-767.

¹⁵⁴ Weinberg, *A World at Arms*, 767.

¹⁵⁵ Eccles, *Logistics in the National Defense*, 40-41.

symbols of German progress to the world.¹⁵⁶ In the same manner, the German regime used the airplane as a symbol of its wartime technological prowess. The *Luftwaffe*'s battle test over the skies of the Spanish Civil War in the 1930s frightened both Britain and the US. Despite its modest abilities, the *Luftwaffe* was most the feared arm of the Third Reich.¹⁵⁷ According to James Corum in *The Luftwaffe*, "People throughout the world received the impression that the Germans had created a fearsome air force that could obliterate entire cities."¹⁵⁸

The Third Reich translated this ideological love of the internal combustion engine, in its ground and air form, to a strategy for gaining the Heartland in the East.¹⁵⁹ For Hitler, the Heartland represented *Lebensraum*, or living space, for the German people, and the economic engine of Mackinder's theory.¹⁶⁰ According to Adam Tooze in *Wages of Destruction*, Hitler "was justifying Barbarossa first and foremost as a campaign of economic conquest," this prompted his staff to provide a rosy estimate of a future four million tons of grain from the Ukraine and untold quantities of oil from the Caucasus as the lifeblood of the German Army.¹⁶¹ Increased Soviet shipments of resources to Germany in the spring of 1941 (part of the Nazi-Soviet Non-Aggression Pact that also partitioned Poland along the Bug River), to include rubber from Japan, did little to deter Hitler's plan.¹⁶² Hitler preferred to assimilate resources via conquest rather than reconciliation.

As in the West a year prior, the Third Reich started war in order to scavenge resources, much as its ally in the Pacific had done. During the build-up to Operation Barbarossa, the US had already set up Lend-

¹⁵⁶ Van Creveld, *Supplying War*, 142.

¹⁵⁷ Biddle, *Rhetoric and Reality*, 118-119.

¹⁵⁸ James S. Corum, *The Luftwaffe: Creating the Operational Air War, 1918-1940* (Lawrence: University Press of Kansas, 1997), 200.

¹⁵⁹ Tooze, *Wages of Destruction*, 453.

¹⁶⁰ Adolf Hitler and James Vincent Murphy, *Mein Kampf*, Unexpurgated ed., 2 vols. (LaVargne: Bottom of the Hill, 2010), 121.

¹⁶¹ Tooze, *Wages of Destruction*, 459.

¹⁶² Weinberg, *A World at Arms*, 203.

Lease with Britain. With the attack in the East, the Germans would now bring the Great Western Heartland, and its immense resources, to the defense of the Eastern Heartland.

Given their stunning success on the Western Front in 1940, the German high command believed they could quickly maneuver their armored forces, supported by the concentration of supply trucks and the *Luftwaffe* overhead, allowing “the Red Army to be broken on the Dnieper-Dvina river line.”¹⁶³ Beyond this line, 300 miles from the Polish-German border, the German Army’s land logistics would be at their limit.¹⁶⁴

The problem with such a logistics strategy was its lack of realistic mobile supply to back it up. As Richard Overy notes in “Transportation and Rearmament in the Third Reich,” by 1939 the Autobahn had only 25% of its 14,000 kilometers of roadway complete.¹⁶⁵ In addition, internal German automobile production lagged well behind that of the Allies before and during the war.¹⁶⁶ The reason for this lag was related to the German requests from the Soviet Union after the Polish invasion: lack of petroleum.¹⁶⁷ When the Eastern Front offensive began, this dearth of mobile supply left the Germans with only 6,600 motorized vehicles to bridge the gap between the railheads and the fast-moving mechanized combat units.¹⁶⁸ The insufficient road network and shortage of vehicles led the Germans to scrounge their needs from the

¹⁶³ Tooze, *Wages of Destruction*, 453. Unbeknownst to the Germans, such heavy use of motorized supply, would eventually force them to use the *Luftwaffe* as an Air to Ground LOC, effectively taking away from its combat effectiveness.

¹⁶⁴ Van Creveld, *Supplying War*, 153.

¹⁶⁵ Overy, “Transportation and Rearmament in the Third Reich.”

¹⁶⁶ Overy, “Transportation and Rearmament in the Third Reich,” 406. Britain produced nearly 1 million wheeled vehicles during the war, Germany only 800,000.

¹⁶⁷ Overy, “Transportation and Rearmament in the Third Reich,” 406.

¹⁶⁸ Van Creveld, *Supplying War*, 144.

Western conquered countries, and to rely on older technologies: the railroad, the horse-drawn cart, and the human- powered *panje* cart.¹⁶⁹

The Railroad Rides Again

The war was to be a railway war, just as 1870 and 1914 had been railway wars.

Richard Overy

Despite their obsession with cars and airplanes, rails would bring the Germans to war. The amount of rail used to perform the build-up for Operation Barbarossa, the invasion of the Soviet Union, illustrated how much the Germans still depended on the iron horse. The Germans moved the 141 Divisions for Operation Barbarossa and their supplies to the front in more than 33,500 trainloads between January and June 1941.¹⁷⁰ In addition, the number of trains traveling to the East swelled from 84 per day after the invasion of Poland, to 220 trains by the beginning of Barbarossa.¹⁷¹

The Germans, however, failed to heed the lessons about train supply from the German Wars of Unification forward. As at Königgrätz, the Franco-Prussian War, and 1914 the trains worked masterfully in the run-up to the Eastern campaign. The German command instituted the Otto program to reengineer the rail lines in Poland going east into Russia and to prepare the train system for the push.¹⁷² Most importantly, the Germans had to plan to convert Russian wide-gauge railroads to the German-Polish standard.¹⁷³ Given the need for secrecy and the limited capacity of the railroad to deliver the massive 141-

¹⁶⁹ Omer Bartov, *Hitler's Army : Soldiers, Nazis, and War in the Third Reich* (New York: Oxford University Press, 1991), 12. Bartov describes how the mobile Germany Army quickly became human-powered early in the Eastern Front Campaign. Van Creveld, *Supplying War*, 147 and 150. The Germans shipped a total of 12,000 tons of motor transport from Belgium and 2,000 tons from Holland on just one day in May 1941.

¹⁷⁰ Arvo L. Vecamer, "Deutsche Reichsbahn - the German State Railway in WWII " <http://www.Feldgrau.com> (accessed 10 April 2012).

¹⁷¹ Vecamer, "Deutsche Reichsbahn."

¹⁷² Vecamer, "Deutsche Reichsbahn."

¹⁷³ Tooze, *The Wages of Destruction*, 454.

division army to the East, the railroad planning led to a stunning success initially.¹⁷⁴

Shortcomings, however, were manifold. Despite considerable logistics planning to start Operation Barbarossa, the Third Reich failed to adequately train, plan, and equip their *Eisenbahntruppe* for the railroad push into foreign territory.¹⁷⁵ This would place heavy reliance on motorized supply for the mechanized divisions while leaving the rest of the Army to walk—as it had done for the last three major German wars. Such heavy use of mobile supply would create a fuel shortage that influenced not only the *Luftwaffe* and combat ground forces, but also the *Eisenbahntruppe* themselves.¹⁷⁶ Thus, when the Eastern Front began on 22 June 1941, the Land LOC was fragile and fraught with peril.

LOCs meet Mackinder's Heartland

On June 22, 1941, the Germans invaded the Soviet Union. It would be the most important front of the war. According to Gerhard Weinberg in *A World At Arms*, “The majority of the fighting of the whole war took place on the Eastern Front; more people fought and died there than on all other fronts of the war around the globe put together.”¹⁷⁷ As both the Germans and Soviets would discover, even modern mobile armies covered by airpower were at the mercy of the weather. The spring thaw and the fall rains would turn the poor roads into vehicle-swallowing morasses. Despite shortcomings in logistics planning, the initial push by the Germans in three groups—Army Group North, Army Group South, and Army Group Center—achieved staggering success.

The *Luftwaffe*, using 60 percent of its 3,428 aircraft armada, devastated the Soviet Air Force, destroying over 4,000 planes in under a

¹⁷⁴ Van Creveld, *Supplying War*, 153.

¹⁷⁵ Van Creveld, *Supplying War*, 153.

¹⁷⁶ Van Creveld, *Supplying War*, 153. The *Eisenbahntruppe* were “allowed only 1,000 motor vehicles, most of which were inferior French and English material, so that a bare sixth of their formations was fully motorized.”

¹⁷⁷ Weinberg, *A World at Arms*, 264.

week.¹⁷⁸ By July, Army Group North had thrust past the 3rd, 4th, and 10th Soviet Armies outside of Minsk.¹⁷⁹ Army Group North “grabbed another 300,000 prisoners even as it seized the cities of Orsha and Smolensk on the road to Moscow.”¹⁸⁰ Army Group South raced towards Kiev and routed two Soviet Armies while holding other enemy forces under siege at Odessa.¹⁸¹ By the end of the month, Army Group North was only 80 miles short of Leningrad.¹⁸² In total, by 1 October 1941, the three-million man German army had cut the Soviet Army from five and a half million strong to under three million.¹⁸³

The LOCs established by these fast and deep envelopments were tenuous at best. When compared to World War I, the *Eisenbahntuppe* performed admirably. By July 10, 1941, they had already converted over 300 miles of railroad gauge behind Army Group North.¹⁸⁴ However, the rail capacity only allowed one train, vice the ten required, to reach the forward supply depot at Dunaburg, which itself was more than a hundred miles from the front.¹⁸⁵ Meanwhile, the mobile supply units attempted to keep up with the mechanized brigades but suffered on the primitive Russian roads, which even small amounts of rain rendered unusable.¹⁸⁶ Muddy roads caused the mobile supply units to use fuel at a 40% greater rate than predicted and played havoc with tires—a critical resource since the Allies had choked off rubber imports from the Atlantic.¹⁸⁷ Thus, by the beginning of November, the Germans had lost nearly 330,000 of their total 500,000 vehicles.¹⁸⁸

¹⁷⁸ Weinberg, *A World at Arms*, 264 and Price, *The Luftwaffe Data Book*, 42.

¹⁷⁹ Keith E. Bonn, ed. *Slaughterhouse: The Handbook of the Eastern Front* (Bedford: Aberjona Press, 2005), 20.

¹⁸⁰ Weinberg, *A World At Arms*, 266.

¹⁸¹ Bonn, *Slaughterhouse*, 20.

¹⁸² Van Creveld, *Supplying War*, 160.

¹⁸³ Bonn, *Slaughterhouse*, 17.

¹⁸⁴ Van Creveld, *Supplying War*, 160.

¹⁸⁵ Van Creveld, *Supplying War*, 160,

¹⁸⁶ Van Creveld, *Supplying War*, 160.

¹⁸⁷ Van Creveld, *Supplying War*, 157.

¹⁸⁸ Bonn, *Slaughterhouse*, 18.

Behind these supply units, marched on foot and rode on horseback the rest of the German Army. As the mobile supply units came back towards the infantry, this clogged the roads and sometimes halted movement altogether. Thus, “instead of the logistics apparatus following in the wake of operations, it was supposed to precede them, a procedure probably unique in the annals of modern war.”¹⁸⁹ By late July, this dire supply and communications situation resulted in many units supplying themselves via hand-pulled *panje* carts.¹⁹⁰

The LOC quagmire of inadequate transportation, both rail and truck, on inadequate mud-ridden roads stopped the German advance. They now had to wait for the first freeze to resume operations.¹⁹¹ As the cold weather hit in November, the Third Reich pushed forward toward Moscow, but the force was a shell of itself. During the final push to the Soviet capital, the German High Command rated its 141 divisions as only “equivalent to 83 full-strength divisions.”¹⁹² As the Germans stalled on a 1400-mile front, located some 700 miles from Polish-Soviet border, the Soviets counterattacked on 5 December 1941.¹⁹³ With the first American Lend-Lease Aid arriving in the Soviet Union, and the Japanese attack on Pearl Harbor on December 7, 1941, the Germans would find themselves fighting for the Eastern Heartland, while being besieged by the Great Western Heartland on all sides.

Soviet Counterattacks: Air as LOC

The *Luftwaffe* provided the critical combat power the *Wehrmacht* required during the deep envelopments into Soviet territory in the second half of 1941. As fresh Soviet reserves with shorter LOCs pressed into the German Front, the *Luftwaffe* would be called on both to provide

¹⁸⁹ Van Creveld, *Supplying War*, 155.

¹⁹⁰ Bartov, *Hitler's Army*, 12.

¹⁹¹ Black, *World War Two*, 84.

¹⁹² Bonn, *Slaughterhouse*, 18.

¹⁹³ Bonn, *Slaughterhouse*, 22.

kinetic power and resupply efforts.¹⁹⁴ So desperately extended were the German supply lines, Hitler ordered Army Group Center to hold in position. Army Group Center had nowhere to go and no railroads to fall back on; if they were overtaken, they risked losing all of their heavy equipment.¹⁹⁵ As the Soviet offensive cut between German Army Groups North and Center, they isolated 100,000 German troops around Demyansk.¹⁹⁶

It was in the Demyansk pocket that Hitler ordered the *Luftwaffe* to resupply the surrounded Army.¹⁹⁷ In a herculean effort, the *Luftwaffe* supplied Demyansk and many other areas along the front into the spring of 1942.¹⁹⁸ According to Richard Muller in *The German Air War in Russia*, “For the Demyansk pocket alone, Fliegerkorps VIII recorded 12,435 operational flights by transport aircraft and their fighter escort and lost 265 aircraft in the process.”¹⁹⁹ Partially due to this success in aerial resupply, the Germans held the Demyansk pocket.²⁰⁰ This perception of capability in aerial resupply would lead to fatal consequences the following winter at Stalingrad.²⁰¹

During the initial winter operations in Soviet territory, the weather took a toll on soldiers and equipment. Aircraft suffered from cold starts that blew seals, requiring precious rubber to repair.²⁰² Supply trucks suffered the same fate as they had trouble starting and required more maintenance than in warmer weather.²⁰³ Even the railroads, which were less susceptible to cold than aircraft or trucks, suffered under the

¹⁹⁴ Richard Muller, *The German Air War in Russia* (Baltimore, Md.: Nautical & Aviation Pub. Co. of America, 1992), 62.

¹⁹⁵ Weinberg, *A World at Arms*, 293.

¹⁹⁶ Weinberg, *A World at Arms*, 295.

¹⁹⁷ Muller, *The German Air War*, 62.

¹⁹⁸ Weinberg, *A World at Arms*, 295.

¹⁹⁹ Muller, *The German Air War*, 63

²⁰⁰ Black, *World War Two*, 114. The Germans also employed hedgehog defensive tactics “based on the main communication nodes, and were able to prevent major breakthroughs.”

²⁰¹ Weinberg, *A World at Arms*, 295.

²⁰² Murray, *Strategy for Defeat*, 118-119.

²⁰³ Murray, *Strategy for Defeat*, 118.

egregious conditions. Army Group Center leadership worried in January 1942 that “in temperatures below -15° Centigrade, over 50 percent of its supplies [by rail] would not get through, and in heavy snow the entire supply system might cease to function.”²⁰⁴ On the Eastern Front, if the mud did not completely slow down both LOCs and combat power, then winter did.

The initial Soviet success stalled by the spring of 1942. Much like the German High Command, Stalin discovered that running a 1400-mile front proved a tall logistical task.²⁰⁵ Despite repeated requests from his generals to concentrate his forces and simplify LOCs, Stalin pushed the broad-front war believing he could rout the Germans and prevent a German offensive in the summer of 1942.²⁰⁶ The Soviets also lagged behind the German ability for adroit maneuver with mobile attack and supply efforts. They would have to wait for internal production and the more than 400,000-wheeled vehicles arriving from the Great Western Heartland later in 1942.²⁰⁷

Stalingrad: The Final Supply Chain Solution

As in the West, the Germans relied on the resources, whether raw materials or industrial production, of the areas they conquered to feed their population and their war machine. The initial thrust into the Heartland had consumed a staggering amount of men and material. By November 1941, the Germans had lost 686,000 men, over 330,000 vehicles, and 65 percent of their tanks.²⁰⁸ Added to this, the Germans *Eisenbahntruppe* had expended enormous resources converting or building 107 secondary rail lines from Poland and the Ukraine to the front.²⁰⁹ Six months after the invasion, the supply situation was growing desperate, and the Germans had shortages in spare parts, tires,

²⁰⁴ Murray, *Strategy for Defeat*, 118.

²⁰⁵ Black, *World War Two*, 114.

²⁰⁶ Black, *World War Two*, 113.

²⁰⁷ Bonn, *Slaughterhouse*, 65.

²⁰⁸ Bonn, *Slaughterhouse*, 18

²⁰⁹ Vecamer, “Deutsche Reichsbahn.”

and engine oil.²¹⁰ As Martin Van Creveld notes in *Supplying War*, “as to the ‘supply’ of tires, this was so small, as to merit one adjective only—ridiculous.”²¹¹ After such a consuming operation, the resource-starved German state, which relied on a strategic parasitic supply chain—whether French trucks, Belgium rail cars, or Soviet oil—turned to the Caucasus for precious petroleum. The push for Stalingrad in June 1942 took place exactly as the Allies began to gain the upper hand in the Atlantic and while the US were defeating the Japanese at Midway, guaranteeing a Pacific Route for lend-lease to the Soviet Union. The German state in Mackinder’s unreachable Heartland was squeezed from all sides.

As the mud dried across the Heartland after a long spring thaw, the Germans began the drive to Stalingrad on June 22, 1942. Once again, the *Luftwaffe* helped drive the Soviets back and destroy their LOCs, while keeping the Soviet Air Force away from German LOCs. German Bombers and Stukas helped the Army move southward more than 50 miles in less than two weeks, creating a near panic in the Soviet Forces.²¹² The Germans captured Rostov on 20 July and pushed south into the Caucasus by early August, capturing the oilfields at Maikop.²¹³

Although the Soviets initially reeled in defeat, Stalin hoarded his reserves near Moscow in the spring of 1942, convinced that Hitler would try to finish Barbarossa.²¹⁴ As the Germans pushed South and East, this allowed the Soviets to use their rail network to reinforce Stalingrad and prepare for their counterattack later in the year.²¹⁵

The well-documented, bitter fighting at Stalingrad was emblematic of the importance of the Heartland. Sitting at the southern edge of the Heartland and geographically at the entrance to Caucasus, Stalingrad

²¹⁰ Van Creveld, *Supplying War*, 176.

²¹¹ Van Creveld, *Supplying War*, 176.

²¹² Murray, *Strategy for Defeat*, 122.

²¹³ Black, *World War Two*, 116.

²¹⁴ Weinberg, *A World at Arms*, 412.

²¹⁵ Black, *World War Two*, 116.

was all-important. For the Germans, Stalingrad represented resources and a chance to hold the majority of the Heartland they had gained in the last year; for the Soviets, it represented state survival and a chance for the great industrial machine to get fully up to speed.

Unlike the central thrust of 1941, which stalled outside of Moscow, the southern front around Stalingrad had a longer LOC from the German border. The long LOC and bitter resistance from the Soviets caused the German offensive to devolve into fierce street-to-street fighting in Stalingrad proper throughout the fall. Despite gaining nine-tenths of the city, the Germans were woefully short of fuel, ammunition, and other supplies.²¹⁶ More ominously, the *Luftwaffe* was now grinding down after three years of constant combat. In taking Sevastopol as they approached Stalingrad, the Germans lost more than 300 aircraft to only 77 for the Soviets.²¹⁷ Just as the *Luftwaffe* was losing its lift, the Soviet Air Force began to gain strength from both its domestic production and lend-lease aircraft.²¹⁸

The Soviets, rather than focus on the entire front, looked solely to envelope the Germany Sixth Army, which was involved in the Stalingrad fight.²¹⁹ Helping the Soviet efforts in this build-up were Allied operations in North Africa. The Americans and British landed in North Africa on November 9, 1941, forcing Hitler to pull resources bound for the Eastern Front and redirect them to Tunisia.²²⁰ Ten days later the Soviets struck out against General Paulus and the Sixth Army.²²¹

In a huge offensive, using five Armies and more than 1400 ground-attack aircraft, the Soviets destroyed the northern flank of the Sixth Army held by the weak and undersupplied Romanian armies.²²²

²¹⁶ Murray, *Strategy for Defeat*, 150

²¹⁷ Overy, *The Air War*, 54

²¹⁸ Overy, *The Air War*, 54.

²¹⁹ Weinberg, *A World at Arms*, 447-448.

²²⁰ Weinberg, *A World at Arms*, 447.

²²¹ Murray, *Strategy for Defeat*, 150.

²²² Overy, *The Air War*, 55 and Murray, *Strategy for Defeat*, 150.

By November 20, 1942, the Soviets had the Sixth Army surrounded. The Germans then attempted to convert their long and inadequate land LOC to aerial supply.²²³

Lift for the Luft

The successes in the winter of 1941-42 to resupply the front by air, most notably in the Demyansk pocket, held promise for the German High Command. However, the situation in the air had changed in the intervening months. Supplied by their ever-growing manufacturing and the Lend-Lease program, the Soviet Air Force now had numerical superiority to the *Luftwaffe*—some 25,000 aircraft for the Soviets versus less than 15,000 for the Germans over all of the West, the Mediterranean, and the Eastern Front.²²⁴ For the first time since the Battle of Britain, the *Luftwaffe*'s air superiority, and by extension its air LOC into Stalingrad, were in jeopardy.

The aerial resupply of the Sixth Army began on November 24, 1942. In December to early January, the *Luftwaffe* had some success. On December 21, they flew 144 sorties into Stalingrad and delivered 362 tons of supplies, likewise on January 4; they flew 145 sorties and delivered 270 tons.²²⁵ Unfortunately, for the Sixth Army, they were promised 300 tons per day and rarely received that amount with any consistency.²²⁶ In addition, the winter weather and the much stronger Soviet aircraft took their toll. In addition, the *Luftwaffe* had to fly much further, using greater amounts of fuel, than for the resupply operations earlier in the year.²²⁷ When the Soviet Army further reduced the Stalingrad pocket by taking the main airport at Pitominik, the airlift dwindled to less than 100 tons per day.²²⁸ On February 2, 1943, General Paulus surrendered the Sixth Army, losing 130,000 soldiers in

²²³ Overy, *The Air War*, 55.

²²⁴ Overy, *The Air War*, 55.

²²⁵ Muller, *The German Air War*, 96-97.

²²⁶ Weinberg, *A World at Arms*, 451.

²²⁷ Weinberg, *A World at Arms*, 452.

²²⁸ Weinberg, *A World At Arms*, 453 and Muller, *The German Air War*, 97.

the final encirclement, with over 90,000 taken prisoner.²²⁹ The *Luftwaffe* suffered similar devastation, losing more than 490 of the transport and bomber aircraft trying to resupply Stalingrad.²³⁰

The Long Slog Westward

Once again buoyed by success, Stalin began a large counteroffensive towards the North and Center German Army Groups. This resulted in a relief of besieged Leningrad; however, the Russian land LOCs again stalled, as their tanks were unable to compete with the German defensive moves in the spring of 1943.²³¹ As the Soviets pushed west, a familiar communications problem emerged, they needed to rebuild railways and supply their troops just as the Germans had done going east.²³² The problems of supplying an army over the Heartland cut both ways.

However, the German re-attacks into the Soviet lines in March 1943 would represent their last success on the Eastern Front. Without much needed resources from the Caucasuses, oil continued to be in short supply, hampering the mobility of mechanized forces. In addition, the sheer destruction of mobile supply vehicles due to weather, poor roads, and the Soviet Air Force, further hampered the Germans.²³³ As the Russians battered them in the East, the Allied Combined Bomber Offensive began to pull the *Luftwaffe* further to the West. The Germans made one last offensive attempt at Kursk in July. This was also the last gasp for the *Luftwaffe* in the East. The Russian war machine, aided and abetted by Lend-Lease and the Great Western Heartland, vastly

²²⁹ Weinberg, *A World at Arms*, 453.

²³⁰ Overy, *The Air War*, 55.

²³¹ Black, *World War Two*, 131.

²³² Stephen G. Fritz, *Ostkrieg : Hitler's War of Extermination in the East* (Lexington: University Press of Kentucky, 2011), 421. Fritz notes, "the dash to Berlin...required a considerable logistic effort...which in turn, necessitated a rebuilding of the Polish railroad system."

²³³ Bonn, *Slaughterhouse*, 46-47. Bonn states, "Whereas the late winter / spring of 1942/43 had been periods of rest and refitting for the Germans, the corresponding period of 1944 was one unrelenting struggle for survival."

outnumbered the German fliers. Although they fielded nearly 2,000 planes at Kursk, “the Soviet armies enjoyed at times superiority in fighter aircraft of as much as 10:1.”²³⁴ Ultimately, the sheer weight of the Soviet Union decimated the German armies: “the killed, captured, and missing . . . from the beginning of June [1944] to the middle of September [1944] were in excess of one million...accompanied by huge loss of material...vast numbers of tanks and guns were destroyed in the fighting.”²³⁵

Although valiant in effort, the German LOC network never recovered from the first offensive operations in 1941. As the situation became more dire over the next two years, the Germans would increasingly rely on airpower to augment their supply lines and provide firepower. Meanwhile, the Soviets, with increasing manufacturing ability and supplemented with trucks, tanks, and aircraft from the United States, would push the Germans out of the Heartland and own it all themselves.

The Great Pacific War

Was it Over When the German's Bombed Pearl Harbor?

Bluto Blutarksy

As the Germans slowed their advance on Moscow, the Japanese struck out in the Pacific on their own parasitic, horizontal grab for resources. Encouraged by initial German success and convinced that United States, Britain, and other western nations represented a threat to their economic interests in the Pacific, the Japanese invaded French Indochina in 1940.²³⁶ The operations promised not only rice, but also rubber, a key ingredient for both the Japanese and, after Operation Barbarossa began, their increasingly close Allies the Germans.²³⁷ According to Jeremy Black in *World War Two: A Military History*, it was

²³⁴ Overy, *The Air War*, 55.

²³⁵ Weinberg, *A World at Arms*, 750.

²³⁶ Weinberg, *A World at Arms*, 254.

²³⁷ Weinberg, *A World at Arms*, 82-83.

the US trade embargo placed on petroleum bound for Japan in protest of the Japanese invasion of French Indochina, that led to Pearl Harbor.²³⁸ Further heightening the tension between the US and Japan was the agreement in May 1941 for the lend-lease to move into China and the June 1941 establishment of a US-China military mission.²³⁹

On December 7, 1941, the Japanese attacked Pearl Harbor followed in the next few weeks by the Philippines, Malaysia, Burma, and the Dutch East Indies.²⁴⁰ In six short months, they had gained a vast Pacific empire consisting of more than 90 million people and containing the resources—most importantly oil—the Japanese empire needed.²⁴¹

Midway: The End Begins

Hitler's Nazi ideology had co-opted Mackinder's Heartland, and he based his Eastern Campaign on motives that were at once powered by race and resources.²⁴² Similarly, Japan had a parasitic resource strategy in the Pacific and Southeast Asia that was also founded on a sense of racial superiority. This strategy had become obvious nearly fifty years earlier as the industrial revolution affected the Japanese and the world. By the turn of the century, both the US and Japan recognized the struggle for the Pacific would be over resources and be contested by their two governments.

On the US side, the US Navy defined and refined a plan for the defeat of Japan called War Plan Orange. Beginning in 1897, United States naval planners, including Admiral Dewey, theorized that the Japanese would try to take the Philippines and deny the US LOCs into the Southeast Pacific.²⁴³ The initial strategy for the US Navy revolved around any potential conflict turning into an economic war, in which the

²³⁸ Black, *World War Two*, 89.

²³⁹ Black, *World War Two*, 90

²⁴⁰ Weinberg, *A World at Arms*, 322.

²⁴¹ Overy, *The Air War*, 90 and Jeremy Black, *World War Two*, 101.

²⁴² Kearns, 18; Tooze., *The Wages of Destruction*, 452.

²⁴³ Edward S. Miller, *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897-1945* (Annapolis: The Naval Institute Press, 1991), 24-25.

US would use its naval power and industrial might to grind Japan's shipping to a halt.²⁴⁴

On the Japanese side, the Navy continually built their carrier, surface fleet, and submarine force to contest the United States. According to Mark Peattie in *Sunburst*, by the 1930s "The [Japanese] Navy General Staff . . . recognized the increasing value of Micronesia as a base for operations against the United States Navy."²⁴⁵ Most importantly, the Japanese believed that by building their naval aviation with a longer fuel radius, they could outrange US Naval aviation.²⁴⁶ Given its limited oil resources and the massive amounts of fuel a carrier navy required, such planning meant the island nation would need to go outward to secure its resources before conflict with the US. However, the Japanese Navy spent little time thinking about "the prospects of fighting a long war with an enemy so superior in industrial, scientific, and technological resources."²⁴⁷

Midway was the first big test of the two navies and the nations' Pacific strategies. Midway Island, located directly west of Hawaii, represented a critical geographic point. If the Japanese could maintain their power base at Midway, they could continually threaten and challenge the fleet at Pearl Harbor.

On June 3, 1942, two weeks before the Germans made the push for Stalingrad and the resource rich Caucasus, Japanese and American carrier groups met at Midway. While the US lost one carrier, the Japanese lost four large carriers and one small carrier.²⁴⁸ Coupled with the loss of two Japanese carriers at the Battle of the Coral Sea a month earlier and the failure to sink the US carriers, which were out to sea on December 7, 1941, the Japanese, were effectively prevented from

²⁴⁴ Miller, *War Plan Orange*, 70.

²⁴⁵ Peattie, *Sunburst*, 80.

²⁴⁶ Peattie, *Sunburst*, 80.

²⁴⁷ Peattie, *Sunburst*, 198.

²⁴⁸ John. H. Bradley, "Atlas for the Second World War," ed. Thomas E. Griess (Garden City Park: Square One Publishers, 2002), 15.

threatening the US Navy for the rest of the war.²⁴⁹ In addition, Japan lacked the robust logistics repair and communications routes the Americans possessed. The Americans made repairs quickly and re-deployed their damaged ships much faster than the Japanese did.²⁵⁰ In essence, Japan “lost the strategic and operational initiative relatively early in the war.”²⁵¹ As in the Battle of the Atlantic and the land battles in Europe, airpower was necessary for control of LOCs in the Pacific.

With the loss at Midway, the Japanese could not threaten American shipping. In a reverse form compared to the Battle of the Atlantic, the Americans used their submarines to close in on Japanese merchant shipping. In 1942, the Japanese had no convoy support operations for their desperately needed merchant ships. Even by 1943, the Japanese had only marginal convoy support leading to numerous sinkings by US submarines, Naval Aviation, and US Army Aircraft, including a convoy containing 3,000 Japanese soldiers bound for New Guinea on March 3, 1943.²⁵² Allied command of the sea took a devastating toll on Japanese shipping. By August 1945, the US had sunk over 4.5 million tons of merchant ships by submarine and more than 2 million tons via naval and land-based airpower.²⁵³ While the early US sea power advantage choked off Japan’s LOCs and merchant supply chains, it also gave the US the freedom to move Soviet Lend-Lease items through the Pacific. As previously mentioned, this route became the largest LOC for Lend-Lease to the Soviet Union.²⁵⁴

After the Coral Sea and Midway, the US set up its two-pronged attack so widely predicted during the previous fifty years of internal

²⁴⁹ Gray, *The Leverage of Sea Power*, 254.

²⁵⁰ Black, *World War Two*, 112. Notably the carrier *Yorktown*, after the Battle of the Coral Sea.

²⁵¹ Gray, *The Leverage of Sea Power*, 254.

²⁵² Thomas E. Jr. Griffith, *MacArthur's Airman: General George C. Kenney and the War in the Southwest Pacific* (Lawrence: University of Kansas Press, 1998), 109-110.

²⁵³ Overy, *The Air War*, 96. See Table 7. Navy submarine total: 4,774,000 tons. Naval aviation total: 1,543,000 tons. Army aviation total: 668,000 tons.

²⁵⁴ Black, *World War Two*, 141; Gray, *The Leverage of Sea Power*, 242

planning for War Plan Orange.²⁵⁵ In one offensive, the Navy and the Marine Corps would take the central chain of islands and work closer to Japan, setting the stage for long-range bombing of the home islands. In the other offensive, US Army forces under General MacArthur would take a South East Asia route to retake the Philippines.²⁵⁶ Given the vast distances in the Pacific, the American two-pronged offensive seems foolish in retrospect. The LOC for both approaches would be thin at best, or so it seems. However, as Jeremy Black notes in *World War Two*, “the real story was the Americans had enough resources to do both.”²⁵⁷

The fight for the rest of the war involved major sea battles around the Philippines and brutal Marine Corps and Army amphibious landings on dozens of islands throughout the Pacific. Each island campaign involved a fractal of the larger integration of sea, land, and air combat power and logistics support that typified the war.

Guadalcanal, the early campaign for the Solomon Islands, in August 1942, represents an example of how this networked system of combat power and LOCs would work for the US throughout the rest of the war. The initial amphibious landings went poorly for the US. The Navy failed to complete construction of an airfield for both supply flights and combat missions.²⁵⁸ The Japanese Navy also chased the US carriers out to sea along with the Marine supply boats, further complicating the logistics situation.²⁵⁹ This left the Marines without

²⁵⁵ Gray, *The Leverage of Sea Power*, 253; Miller, *War Plan Orange*, 336. According to Miller, “The mid-Pacific [vs. the Philippines] had been the navy’s favored avenue of attack since 1907.”

²⁵⁶ Gray, *The Leverage of Sea Power*, 258.

²⁵⁷ Black, *World War Two*, 143; Gray, *The Leverage of Sea Power*, 253. Gray avers the, “depth and breadth and depth of the US economy enabled construction of a maritime instrument of a scale and quantity which rendered it a near-perfect expression of the American way of war... [relying] fundamentally on the principle of mass, on brute force.”

²⁵⁸ Weinberg, *A World at Arms*, 342.

²⁵⁹ Weinberg, *A World at Arms*, 342.

adequate air cover or supplies.²⁶⁰ Both the US and the Japanese fought fiercely to resupply their positions and go on the offensive. Ultimately, the US naval air and surface forces won the battle, denying the Japanese the ability to resupply and bring combat power ashore.²⁶¹ This network of combat power across all three domains in combination with logistics support defined the island-hopping campaign until the Japanese surrender. The enduring legacy of each successful campaign, despite the significant human toll, was the ability of the Great Western Heartland to form a new links in its logistics system.²⁶²

When taken from and the admittedly narrow perspective of supply-chains and logistics, by June 1942, the Second World War was over. The Germans had just begun their ill-fated last attempt to grab the oil in the Caucasus, the Americans had sent nearly all of the Japanese carriers to the ocean floor at Midway, and the Allies had begun to turn the tide on the U-boats in the Atlantic. Despite the many millions more that would die in the fighting, the Great Western Heartland and its Allies had surrounded Germany and Japan and would soon drown them with industrial production.

While the Japanese and Germans struggled to outrun naval blockades and connect their war economies, to little effect, the Allies, using the engine of the American economy, integrated their war making efforts worldwide. ²⁶³ The US and its Allies opened up sea-land LOCs protected by airpower across the world's two biggest oceans. The Great Western Heartland anchored the world's great strategic supply chain.

²⁶⁰ Weinberg, *A World at Arms*, 342.

²⁶¹ Allan Reed Millett and Peter Maslowski, *For the Common Defense : A Military History of the United States of America*, Rev. and expanded. ed. (New York: Free Press, 1994), 441.

²⁶² Black, *World War Two*, 139.

²⁶³ Roskill, *The War at Sea*, 482-484. Appendix N lists all blockade running between Germany and Japan from 1941-1943. In sum, the Axis moved less than 180,000 tons of shipping in that time.

Sea LOCs for Atom Bombs: Technology and the Pacific

Lemay told Arnold that he would run out of targets by September 1

Michael Sherry

From the initial attack at Pearl Harbor on, the carrier was the key technological revolution in the Pacific. Even more so than in the Atlantic, airpower was necessary not only to seek out and attack the enemy fleet, but also to project power ashore. Coupled with USAAF long-range bombers and a dedicated submarine fleet, the carrier was able to destroy the Japanese Navy, set-up the logistical system to bomb the home islands, and choke off the Japanese economy.

The invention of the atomic bomb rescued airpower at the strategic level. While the Combined Bomber Offensive did destroy the *Luftwaffe*, its bombing contribution to the war is still the subject of debate. The human toll on USAAF aircrews matched that of Marines in the Pacific at roughly 50,000 casualties. In the Pacific, however, the Atomic Bomb put airpower front and center. By the end of the war, USAAF had the force capable of completing Douhet's vision.

Before the bomb could be dropped however, the Navy had to create an LOC across the Pacific. As the US Navy, and Marine Corps methodically took the islands in the Pacific central chain, they eventually got close enough to build runways for USAAF bombers by late 1944. Using the newest bomber, the B-29 Superfortress, the USAAF could strike Japan.²⁶⁴ Thus, relying on sea communications for support, the US used airpower to attack the home islands.

Coupled with the naval blockade, the air raids devastated the Japanese economy.²⁶⁵ In particular, the fire-bombings of 58 Japanese cities from May to August 1945 brought the Japanese economy to a

²⁶⁴ Michael S. Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven: Yale University Press, 1987), 256.

²⁶⁵ Overy, *The Air War*, 100.

halt.²⁶⁶ Despite the destruction of their external LOCs and their internal economy, the Japanese did not surrender. Only the atomic attacks on Hiroshima and then Nagasaki in August 1945 ended the war.²⁶⁷

Four Theorists Walk into a War

All four theorists, Mahan, Mackinder, Douhet, and Mitchell can explain parts of LOCs and their relationships during World War II. As in World War I, Mahan's thesis that command of the sea translates into economic and wartime success holds for World War II. Mackinder's updated thesis in *Democratic Ideals and Reality* was correct. The Eastern Front and control of the Heartland ended up being the biggest and most important conflict of the war—and railroads were a key transportation mode for such a conflict. His Heartland theory, when transferred to the United States, also explains how and why the nation was able to fight two wars and supply its major Allies in the process. For Douhet, the direct attack on civilian population centers in London, China, and Germany never gained capitulation by the enemy. Only the atomic weapon rescued his theory and solidified air as a decisive LOC in warfare. For Mitchell, the airplane proved able to move forces on the battlefield and as serve an attack element against naval forces. His theory also holds up well to the success of submarines in both the Atlantic and Pacific. Despite the positives of these theories, they still lack key ingredients for explaining the entirety of World War II logistics.

As in World War I, Mahan's ahistorical approach to technology leads to a huge gap in his theory. The airplane, the railroad, and the submarine were so critical to both sea and land LOCs as to render any understanding of World War II meaningless without them. At the same time, the carrier battle fleet actually rescues Mahan's theory from its near death knell at the end of World War I. As Mahan avers "it is

²⁶⁶ Overy, *The Air War*, 100.

²⁶⁷ Overy, *The Air War*, 100. Overy avers that it was only a matter of time before the Japanese surrendered. Regardless, the Japanese did not surrender until after Nagasaki.

through the utilization of position by mobile force that war is determined, just as the effect of a chessman depends upon both its individual value *and* its relative position.”²⁶⁸ The carrier, with its ability to perform reconnaissance, project power onto the land, and engage naval forces, becomes the ultimate expression of position and force. As Mahan’s ship-of-the-line is indispensable to this theory of power projection, so the carrier with its airpower is indispensable to World War II sea power.

Mackinder’s theory promises that a united German state in control of the heartland would be able to establish “her power on a wider base than any in history.”²⁶⁹ Although Germany indeed conquered most of the Heartland as it raced toward Stalingrad in the fall of 1942, it was actually circumscribed by another Heartland—the US. The Americans possessed the same attributes Mackinder gave the Heartland: vast internal resources and large steppes traversed easily by railroad. In addition, due to its sea power (and that of its ally Britain) the US was safe after it improved convoy operations in the Atlantic during the summer of 1942. The Great Western Heartland was then able to produce equipment for itself, and its Allies (most notably the Soviet Union) to precipitate the defeat of Germany and Japan.

Mackinder also believes that “airpower is chiefly an arm of land-power, a new amphibious cavalry, when the contest with sea power is in question.”²⁷⁰ However, as shown in conflicts on the sea and land, airpower became the great arbiter between seaborne and land LOCs. For most of the war, airpower was not sufficient to win a battle or campaign on its own, but without airpower, no battle or campaign could be won. Air power was thus necessary, but not sufficient. Only with the

²⁶⁸ Mahan and Hattendorf, *Mahan on Naval Strategy : Selections from the Writings of Rear Admiral Alfred Thayer Mahan*, xxv.

²⁶⁹ Mackinder, *Democratic Ideals and Reality: A Study in the Politics of Reconstruction*, 81.

²⁷⁰ Mackinder, *Democratic Ideals and Reality*, 84.

detonation of the atomic bomb, did airpower demonstrate the possibility of holding a state's life at risk and thus form its own unitary LOC as a path to decision.

It was in the blinding light of the atomic bomb, that Douhet's theory was rescued. For all the attempts at bombing populations, industries, and military forces, none ended the war, other than that over the skies of Japan. As Bernard Brodie notes in *Strategy in the Missile Age*, "the framework of strategic thought he [Douhet] created is peculiarly pertinent to any general war in the nuclear age."²⁷¹ When coupled with the revolutionary thoughts of Mao, the nuclear weapon would form the crux of international relations from 1945 to the present.

Mitchell's more practical aspects of airpower missed the degree to which airpower could control events on the ground. Although airpower could deliver troops quickly over a wide area during World War II, as Mitchell noted in the British occupation of Iraq in the 1920s, it was hardly sufficient to hold the line on its own. While the *Luftwaffe* successfully supplied the Demyansk pocket in 1941, their attempt to do so at Stalingrad one year later was disastrous. While the Allies successfully airdropped paratroops at Arnhem, they lacked the massive air LOC needed to resupply the effort. And although the Americans could supply a bombing effort from mainland China to Japan by air, it was at great cost. Thus, airpower could quickly supply troops and material to the battlefield, but sustaining such an operation from the air alone would generally prove to be economically or physically impossible.

Mitchell also predicted that aircraft would become a critical part of the commercial economic capacity of the United States. The operations in World War II presaged this as the USAAF Air Transport Command delivered more than 260,000 aircraft to worldwide destinations during

²⁷¹ Brodie, 106.

the course of the war.²⁷² During the last year of the war, Air Transport Command delivered more than 200,000 passengers worldwide.²⁷³ In doing so, the USAAF set the stage for the navigation and infrastructure necessary to sustain future airline industries.

Although Mitchell's strategic bombing theory focused more on industry vice Douhet's civilian targets, again he fared no better. Although strategic bombing in Europe decimated the *Luftwaffe*, the results on the ground were mixed. While the USAAF tried to target any element of the economy they could—from ball bearings to oil refineries—no target set brought the German economy to a halt.²⁷⁴ The success of the bombing effort against Germany is still debated today. Some historians argue that the destruction of the transportation networks did the most damage to the German Economy, while still others argue that the bombing failed to produce any conclusive results.²⁷⁵

Networking Mars: The Horizontal and Vertical Integration of LOCs and Destructive Power

World War II illustrated that a singular approach to transportation, whether by sea, land, or air, was insufficient in modern industrial warfare. The range, speed, cargo capacity, and killing power of technology, particularly its aerial variants, also meant that few internal LOCs were safe from enemy attack.

The nations that succeeded in World War II were able to do two things. First, they integrated fighting power with supply lines to guarantee their own logistics while denying the enemy theirs. Second, they were able to integrate their supply chains both horizontally and vertically to serve battle, the ultimate consumer.

²⁷² Craven and others, 18.

²⁷³ Craven, *The Army Air Forces*, 18.

²⁷⁴ Biddle, *Rhetoric and Reality*, 292.

²⁷⁵ Tooze, *Wages of Destruction*, 649-510; Hughes, *Over Lord*, 292; Biddle, *Rhetoric and Reality*, 293. Tooze and Hughes both assert that the key outcome of the CBO was the destruction of German transportation networks both railroads and internal river/canal shipping. Biddle states, "The ensuing struggle over what bombing had or had not achieved in Europe was political, partisan, and subjective."

The United States through its use of airpower was able to protect not only its sea LOCs in two theaters, but also project power directly onto the industry and population of its enemies. While the German U-Boats struggled against a growing air threat by 1943, the US and British were able to protect their convoys to build up combat power for the push onto German soil. In addition, because the Germans lacked a threatening air presence over the Atlantic, the US was able to ferry combat, and transport aircraft with an unchallenged air LOC to England.

In the Pacific, through its use of the carrier, the US opened up the major trade route with the Soviet Union which would give that nation more than 500,000 wheeled vehicles in their fight for the Heartland. In addition, the US Navy used sea and land communications to eventually build the air infrastructure necessary for the sustained strategic bombing campaign over Japan in 1945.

The Soviet Union, after absorbing a fierce blow from the *Luftwaffe* and *Wehrmacht* in 1941, was able to build and secure its manufacturing base from attack. In doing so, eventually its manufacturing and logistics capability, coupled with US help during Lend-Lease, overwhelmed the German state.

Germany and Japan, despite initial success, were never able to integrate their combat power with their LOCs for the long run. In both cases, their parasitic supply chains required them to obtain external resources, but the quest for resources came at a prohibitive cost in manpower and materiel and brought with it much deserved international condemnation. Attempts by the Axis powers to link their production, resources, and logistics were feeble when compared to those of the Allies. Although war economies in both autocracies produced vast numbers of tanks, aircraft, and trucks, they simply could not keep pace with their enemies.

In the end, the air weapon provided the decisive margin of victory. It evolved as a counter to the quagmire of the Western Front in World War I--what the British inelegantly phrased as "the great sausage grinder." Although early airpower theorists sought to avoid this industrial war of attrition, their progeny found themselves involved in one with global, as opposed to theater-wide, dimensions. Not too surprisingly, the airplane in all of its forms--fighter, bomber, transport, and reconnaissance—proved necessary, if not sufficient, to secure tactical and operational victory in three of the four theaters of the war. It also played a major role in supplying the Asian land war. But in the other three theaters, command of air proved necessary to assure proper feeding of the war machine and in many cases equally necessary to facilitate the combat power of land armies. By December of 1941, the Second World War had become an industrial war of attrition. Once the Allies had linked their superior industrial might to the fronts with lines of land and sea communications that were secured by airpower, the outcome was well-nigh inevitable.

The horizontal integration of the American industrial base with that of the British Commonwealth and the new Soviet state provided the basis for vertical supply chains that united factories with front-line troops. Ships, planes, trains, and trucks all played a role dictated by the distance, geography, and topography of battle. While the tenacity of German and Japanese troops cannot be impeached, inferior logistics networks, particularly when compared to those of the Allies, often diminished their fighting power. In an ironic twist of Nathan Bedford Forrest's dictum, the Germans and Japanese may have indeed been "fustest with the mostest," but the Americans were the "lastest with the lease"; and that had a tremendous impact on the outcome of the war, as well as its aftermath.

Conclusion

The industrial wars of the first half of the twentieth century illustrate the sensitivity of logistics to technology. By the end of World War II, technology gave belligerents the means to transport their troops and supply them almost anywhere on Earth. This simultaneously changed the face of geopolitics, with influences in one theater of war reverberating across the world to another, from American aid to their Soviet ally through the Pacific, to German hopes of resources from Japanese Asian conquest. At the same time, the range, speed, and killing power of industrial technology, exponentiated by the airplane, required a shift in logistics, which in turn required a re-ordering of combat power, national resources, and industrial capacity. For such far-reaching and complex developments in the projection of military power, a single mode of communication—whether sea, land, or air—was insufficient to guarantee victory. Only a proper network of lines of communication, utilizing both horizontal and vertical supply chains, was sufficient to secure victory in industrial warfare.

Mahan, Mackinder, Douhet, and Mitchell all have some explanatory power in terms of lines of communication and twentieth century industrial warfare. With respect to Mahan, those nations that gained command of the sea won both wars. Mackinder's theory explains how technological change affected logistics and geopolitics—even moving the Heartland from his preferred location in Asia and Europe to his secondary preference of North America in the Second World War. Mackinder also accurately described the interplay between land and sea communications, and foreshadowed the contest between the sea-land power of the Allies versus the more specialized sea and land power of the Japanese and Germans, respectively.

Douhet's theory, although inconclusive in conventional bombing campaigns, gained credibility with Hiroshima and Nagasaki. Mitchell's

theory both explains the rise of airpower as a line of communication in its own right, and the concept of attacking a modern industrial supply chain. Despite their successes, any theory that relies on a single mode of logistics is inadequate to explain the networking of communications, combat power, and industrial supply chains necessary to secure victory in large-scale industrial warfare.

Although logistics played a critical function in the defeat of the Central Powers and later the Axis, both wars were not pre-determined by lines of communication. When examining both industrial wars it is tempting to compare the operational logistics acumen of the belligerents and conclude that Allied success was a matter of sheer mass and mobility—more people and more supplies with greater speed of delivery to the great consumer of war.

However, such a focus on logistics cannot account for many factors in both wars. Despite near starvation by the British sea blockade, the German population held out during World War I, creating a popular mythology of the stab in the back, which Hitler exploited fifteen years later. The Germans were able to hold the Soviets at bay for almost three years after Stalingrad, steadily delaying them off in masterful defensive battles, while the British and Americans attrited their aircraft and pilots and eroded their industrial base. When all the logistics power of the American Heartland came ashore in June 1944, with a large measure of air superiority, it still took another year and setbacks at Market Garden and the Battle of the Bulge, before Germany was subdued. The Japanese, despite a near elimination of their economy by strategic bombing and submarine warfare against their commercial and military shipping, held on until the two atomic weapons. Thus, logistics were necessary, but not sufficient for victory.

Despite its inherent logistical focus, industrial warfare was also about ideas. As Mackinder notes in his theory, the Heartland had to be exploited economically for gain. In the First World War, the Germans

could not hold the Heartland long enough to benefit from its resources. In the Second World War, even though Hitler co-opted Mackinder's ideas, the German leaders also missed key warnings. Mackinder understood that any nation that sought to unite the Heartland would bring the world against them. Of note, German arrogance riding on a theory of racial superiority also turned most of the inhabitants of the Eastern Heartland against them. In the Pacific, the Japanese believed they could keep one major power at bay, the Soviet Union, while fighting only the United States. They grossly misunderstood the political will of the United States, and were eventually invaded by the Soviet Union as well.

In both cases, the Germans and Japanese sought to exploit and destroy those they conquered. Rather than co-opt allies or share resources, both nations sought racial harmony through racial purity. From an economic standpoint, this led to stagnant and un-autarkic economies unable to compete with the horizontal integration of the Soviet Union and the United States. Thus, while logistics was the output of policy, it was poor ideas on the part of the Axis that precipitated their defeat as much as their material shortcomings.

To the Future: Networked Communications of the Mind

In the post-World War II era, ideas would become even more important when compared to material factors. Two disparate events ended the wars of mid-century, the atomic attacks on Hiroshima and Nagasaki in 1945 and the communist Chinese victory in the War for East Asia in 1949. Both of these watershed moments ensured that future conflict would move beyond lines of communication and killing power and into a battle of ideas. After the First World War, nations were no longer hampered by the inability to transport goods and services to the front, as had been the case in the age of sail. The railroad and steamship had solved that problem. In the Second World War, the problem was destroying things; and the airplane proved of inestimable value in degrading production and transportation as well as providing

combat power at the front. The atomic weapon, combined with airborne delivery, exponentiated this capability. Within five years of the defeat of Germany and Japan, destroying things was no longer a problem.

Thermonuclear weapons mated to aircraft and eventually missiles rendered destruction trivial and changed the interaction between nation-states, whose survival was now instantly at risk. Some even speculated on the global community's ability to survive a thermonuclear war.

For the two major belligerents in the Post-World War II era, the US and the Soviet Union, the nuclear weapon created a new logic for diplomacy and war. With the thought that any major war between them could destroy them both came a situation in which both sides proceeded with caution in dealing with each. As Thomas Schelling states in his classic *Arms and Influence*, "Any situation that scares one side will scare both sides with the danger of a war that neither wants, and both will have to pick their way carefully through the crisis."¹

With such a risk of all-out war, the US and the Soviet Union chose to fight each other in proxy wars throughout the world. This allowed for other concepts of war, beyond battlefield prowess, to come to the forefront. For example, during the Berlin Airlift, the US used air power to form an air line of communication to keep the western sector of the city fed.² In doing so, the US showed the West could confront the conventional military superiority of the Soviet Union with logistics.

Preeminent in this nuclear era was the ideological struggle between capitalism and communism. Mao Tse Tung unleashed the idea of People's War onto the world with his victory over Chiang Kai-shek in 1949. As older empires crumbled after World War II, in many nations throughout South America, Africa, and Asia newly free nations struggled internally between communist and capitalist ideologies while externally

¹ Thomas C. Schelling, *Arms and Influence* (New Haven, CT: Yale University Press, 2008), 99.

² Roger G. Miller, *To Save a City : The Berlin Airlift, 1948-1949* (College Station, TX: Texas A&M University Press, 2000), 186-187.

influenced by the greater Cold War struggle. Often these conflicts pitted nations with much greater military power and logistics reach against poorer enemies. However, the results did not correspond with military or material capacity.

In Vietnam, the US dropped more than 2 million tons of bombs on South Vietnam between 1965 and 1968, only to cede the country to North Vietnam six years later.³ Fighting an enemy in the North Vietnamese, who required a fraction of the logistics of a modern industrial army, the US bombed vigorously and lost the war of ideas. Destructive capacity and logistics support were no longer sufficient to secure victory. Despite the unprecedented reach and destructive capacity of modern nations since 1945, conflicts have largely been about ideas.

Given the technological changes brought on by the rise of the internet and the ability of space assets to enable instantaneous global communication, technologically sensitive lines of communication are likely to transform as well. Since wars are now more about ideas than killing power, the ability to transmit information to a networked world will become ever more important. Mackinder's closed system has now moved to the mind.

In such a system, a new network will be required. Much as LOCs, combat power, and industrial supply chains were integrated by the Allies for victory in World War II, in the future the information in cyberspace will have to be integrated with the physical. Taking this a step further, as cyberspace comes closer to interaction with the physical, through increased computing technology and bandwidth, the information world

³ Mark Clodfelter, *The Limits of Air Power : The American Bombing of North Vietnam* (Lincoln: University of Nebraska Press, 2006), 129.

may be able to create a physical world.⁴ In other words, the physical lines of communication may inhabit a cyber-universe.

In such a universe, equipment or even personnel, can be digitized and then rebuilt anywhere in the world.⁵ The requirement to move an army across a continent or an ocean will move to cyberspace.

Information and materiel will share the same line of communication, as they did in the age of sail. Hence, the study of Mahan and Mackinder, may have as much relevance for the future as it does for the past. Also likely is a Douhet or Mitchell for the cyber domain. Parsing the ideas of these inevitable prophets might be eased somewhat by studying the impact of previous technologies on the logistics and geopolitics of our world, as we have done here.



⁴ Ray Kurzweil, *The Age of Spiritual Machines : When Computers Exceed Human Intelligence* (New York: Viking, 1999), 145-146. Kurzweil posits that nano assembly technology will be able to use swarms of small machines to recreate a real environment using digital inputs.

⁵ Kurzweil, *The Age of Spiritual Machines*, 145-146.

Bibliography

Articles

- Buckley, John. "Air Power and the Battle of the Atlantic: 1939-1945." *Journal of Contemporary History* 28, no. 1 (1993).
- Busch, John Laurence. "Steamboat Design During the First Generation." *Mechanical Engineering* 134, no. 1 (2012): 36-39.
- "Caudron G.3", http://en.wikipedia.org/wiki/Caudron_G.3#Specifications_.28G.3.29 (accessed 29 Mar 2012).
- Charron, Andrea. "Northwest Passage: Is Canada's Sovereignty Floating Away?" *International Journal* 60, no. Summer 2005 (2005).
- Colon, Raul. "Air Effort over Gallipoli: A Brief Look at the Air Campaign over the Dardanelles" <http://www.century-of-flight.net/Aviation%20history/airplane%20at%20war/turk.htm> (accessed 28 February 2012).
- Duffy, Michael. "Taxis of the Marne, 1914" <http://www.firstworldwar.com/video/taxisofthearne.htm> (accessed 19 March 2012).
- Fordham, Benjamin O. "Revisionism Reconsidered: Exports and American Intervention in World War Iauthor." *International Organization* 61, no. 2 (2007): 277-310.
- "German Torpedoes of World War II", http://en.wikipedia.org/wiki/List_of_World_War_II_torpedoes_of_Germany (accessed 9 April 2012).
- Global Fire Power. "Total Navy Ship by Country" www.globalfirepower.com/navy-ships.asp (accessed February 15 2012).
- Helgason, Gudmundur. "German U-Boat Vii Type" <http://www.uboot.net/types/viic.htm> (accessed 9 April 2012).
- "HMS Dreadnought," [http://en.wikipedia.org/wiki/HMS_Dreadnought_\(1906\)#cite_note-23](http://en.wikipedia.org/wiki/HMS_Dreadnought_(1906)#cite_note-23) (accessed 29 Mar 2012).
- Hogarth, D. G. "Geography of the War Theatre in the near East." *The Geographical Journal* 45, no. 6 (1915): 457-467.
- Isaacs, Jeremy, Laurence Olivier, Carl Davis. "The World at War. [No.] 10, Wolf Pack--U-Boats in the Atlantic, 1939-1944." 1 videocassette. Great Britain: Thames Television, 1973.
- James J. Corbett and James Winebrake. "The Impacts of Globalisation on International Maritime Transport Activity." In *Global Forum on Transport and Environment in a Globalising World*. Guadalajara, Mexico: Organization for Economic Co-operation and Development, 2008.
- Keeling, David J. "Transportation Geography: Local Challenges, Global Contexts." *Progress in Human Geography* 33, no. 4 (2009): 516-526.

- Mackinder, Halford J. "On the Scope and Methods of Geography." *Proceedings of the Royal Geographical Society and Monthly Record of Geography* 9, no. 9 (1897).
- _____. "The Great Trade Routes. (Their Connection with the Organization of Industry, Commerce, and Finance.)." *Journal of the Institute of Bankers* 21 (1900).
- _____. "The Geographical Pivot of History (Reprint of 1904 Article)." *The Geographical Journal* 170, no. 4 (2004): 298-321.
- Mahan, A.T. "Effects of Asiatic Conditions Upon International Policies." *The North American Review* 171, no. 528 (1900): 609-627.
- McNabb, Duncan. "We Measure Success through the Eyes of the War Fighter." *Air and Space Power Journal* XXV, no. 4 (2011): 8-18.
- Overy, R.J. "Transportation and Rearmament in the Third Reich." *The Historical Journal* 16, no. 2 (1973): 389-409.
- Rikard, J. "Battle of Britain, 10 July -- 31 October 1940" http://www.historyofwar.org/articles/battle_of_britain.html (accessed 3 April 2012).
- Russell, Greg. "Alfred Thayer Mahan and American Geopolitics: The Conservatism and Realism of an Imperialist." *Geopolitics* 11, no. 1 (2006): 119-140.
- Shaw, Jon, and James D. Sidaway. "Making Links: On (Re)Engaging with Transport and Transport Geography." *Progress in Human Geography* 35, no. 4 (2011): 502-520.
- Vecamer, Arvo L., "Deutsche Reichsbahn - the German State Railway in WWII," <http://www.feldgrau.com> - Research on the German armed forces 1918-1945 (accessed 10 April 2012).
- "Webmatters: Carte De Route", http://www.webmatters.net/maps/ww1_map_schlieffen.htm (accessed 13 March 2012).
- Witkowski, Paul. "Glider Assault on Eben Emael as an Archtype for the Future." *Infantry* 93, no. 2 (2004): 28-34.

Books

- Abbatiello, John J. *Anti-Submarine Warfare in World War I : British Naval Aviation and the Defeat of the U-Boats* Cass Series--Naval Policy and History. London ; New York: Routledge, 2006.
- Agnew, James B., Clifton R. Franks, William R. Griffiths, Edward J. Krasnoborski, Deanne Beckwith, George Giddings, United States Military Academy. Dept. of History., and Square One Publishers Inc. "Atlas for the Great War." In *The West Point military history series*. Garden City Park, NY: Square One Publishers, 2003.
- Annett, Roger. *Drop Zone Burma : Adventures in Allied Air Supply 1942-45*. Barnsley: Pen & Sword Aviation, 2008.

- Arrighi, Giovanni. *The Long Twentieth Century : Money, Power, and the Origins of Our Times*. "New and updated ed. London ; New York: Verso, 2010.
- Atkinson, Rick. *An Army at Dawn : The War in North Africa, 1942-1943*. 1st ed. The Liberation Trilogy. New York: Henry Holt & Co., 2002.
- Bartov, Omer. *Hitler's Army : Soldiers, Nazis, and War in the Third Reich*. New York: Oxford University Press, 1991.
- Biddle, Tami Davis. *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas About Strategic Bombing, 1914-1945*. Princeton: Princeton University Press, 2002.
- Black, Jeremy. *World War Two: A Military History*. New York: Routledge, 2006.
- Blouet, Brian W. *Global Geostrategy : Mackinder and the Defence of the West* Geopolitical Theory Series. London ; New York: Frank Cass, 2005.
- Bonn, Keith E., ed. *Slaughterhouse: The Handbook of the Eastern Front*. Bedford: Aberjona Press, 2005.
- Bradley, John. H. "Atlas for the Second World War." edited by Thomas E. Griess. Garden City Park: Square One Publishers, 2002.
- Brodie, Bernard. *Strategy in the Missile Age*. New RAND ed. Santa Monica, CA: Rand Corp., 2007.
- Brose, Eric Dorn. *A History of the Great War : World War One and the International Crisis of the Early Twentieth Century*. New York: Oxford University Press, 2010.
- Bungay, Stephen. *The Most Dangerous Enemy: A History of the Battle of Britain*. London: Aurum Press, 2000.
- Chapman, J.W.M. *The Price of Admiralty: The War Diary of the German Naval Attache in Japan, 1939-1945*. Vol. 1. Glasgow, 1982.
- Clausewitz, Carl von, Michael Howard, and Peter Paret. *On War*. Princeton, N.J.: Princeton University Press, 1984.
- Clodfelter, Mark. *The Limits of Air Power : The American Bombing of North Vietnam*. Lincoln: University of Nebraska Press, 2006.
- Corbett, Julian Stafford. *Some Principles of Maritime Strategy* Classics of Sea Power. Annapolis, Md.: Naval Institute Press, 1988.
- Corum, James S. *The Luftwaffe: Creating the Operational Air War, 1918-1940*. Lawrence: University Press of Kansas, 1997.
- Coyle, John Joseph, Edward J. Bardi, and C. John Langley. *The Management of Business Logistics : A Supply Chain Perspective*. 7th ed. Mason, Ohio: South-Western/Thomson Learning, 2003.
- Coyle, John Joseph, Edward J. Bardi, and Robert A. Novack. *Transportation*. 6th ed. Mason, Ohio: Thomson/South-Western, 2006.
- Craven, Wesley Frank, James Lea Cate, United States. Air Force. Office of Air Force History., United States. Air Force. Air Historical Group., and United States. USAF Historical Division. *The Army Air Forces in*

- World War II*. Vol. VII. 7 vols. Washington, D.C.: Office of Air Force History : For sale by the Supt. of Docs., U.S. G.P.O., 1983.
- Defense, United States Department of. *Department of Defense Dictionary of Military and Associated Terms*, 2010.
- Deighton, Len. *Fighter: The True Story of the Battle of Britain*. Ann Arbor: Cape, 1977.
- Dolman, Everett C. *Astropolitik : Classical Geopolitics in the Space Age* Cass Series--Strategy and History. London ; Portland, OR: Frank Cass, 2002.
- Douhet, Giulio, Joseph P. Harahan, and Richard H. Kohn. *The Command of the Air* Fire Ant Books. Tuscaloosa, AL: University of Alabama Press, 2009.
- Eccles, Henry Effingham. *Logistics in the National Defense*. [1st ed. Harrisburg, Pa.: Stackpole Co., 1959.
- Fawcett, Stanley E., Lisa M. Ellram, and Jeffrey A. Ogden. *Supply Chain Management : From Vision to Implementation*. Upper Saddle River, NJ: Pearson Prentice Hall, 2007.
- Fitzsimons, Bernard. *The Illustrated Encyclopedia of 20th Century Weapons and Warfare*. Vol. 23. 24 vols. Milwaukee: Purnell Reference Books, 1979.
- Fritz, Stephen G. *Ostkrieg : Hitler's War of Extermination in the East*. Lexington: University Press of Kentucky, 2011.
- Gilpin, Robert. *War and Change in World Politics*. Cambridge ; New York: Cambridge University Press, 1981.
- Gray, Colin S. *The Leverage of Sea Power: The Strategic Advantage of Navies in War*. New York: Free Press, 1992.
- _____. *Explorations in Strategy* Contributions in Military Studies,. Westport, Conn.: Greenwood Press, 1996.
- Griffith, Thomas E. Jr. *Macarthur's Airman: General George C. Kenney and the War in the Southwest Pacific*. Lawrence: University of Kansas Press, 1998.
- Hitler, Adolf, and James Vincent Murphy. *Mein Kampf*. 2 vols. Unexpurgated ed. LaVargne: Bottom of the Hill, 2010.
- Holmes, Richard, Hew Strachan, Chris Bellamy, and Hugh Bicheno. *The Oxford Companion to Military History*. Oxford ; New York: Oxford University Press, 2001.
- Horne, Alistair. *To Lose a Battle : France 1940*. Rev. and updated. ed. New York: Penguin Books, 1990.
- Hughes, Thomas Alexander. *Over Lord : General Pete Quesada and the Triumph of Tactical Air Power in World War II*. New York: Free Press, 1995.
- Kearns, Gerry. *Geopolitics and Empire: The Legacy of Halford Mackinder*. New York: Oxford University Press, 2009.
- Keegan, John. *The First World War*. 1st American ed. New York: A. Knopf ; Distributed by Random House, 1999.

- _____. *An Illustrated History of the First World War*. 1st ed. New York: A.A. Knopf, 2001.
- Kennedy, Paul M. *The Rise and Fall of British Naval Mastery*. Atlantic Highlands: Macmillan, 1983.
- Kennett, Lee. *The First Air War: 1914-1918*. New York: Simon and Schuster, 1991.
- Kurzweil, Ray. *The Age of Spiritual Machines : When Computers Exceed Human Intelligence*. New York: Viking, 1999.
- Law, John. "Technology and Heterogenous Engineering: The Case of Portuguese Expansion." In *The Social Construction of Technological Systems: New Directiosn in the Sociology and History of Technology*, edited by Thomas P. Hughes Wiebe E.Bijker, and Trevor Pinch. Cambridge: MIT Press, 1987.
- Mackinder, Halford J. *Britain and the British Seas*. Second ed. Oxford: Clarendon 1907.
- _____. *Democratic Ideals and Reality: A Study in the Politics of Reconstruction*. New York: Henry Holt and Company, 1919.
- Mahan, A. T., and John B. Hattendorf. *Mahan on Naval Strategy : Selections from the Writings of Rear Admiral Alfred Thayer Mahan*. Classics of Sea Power. Annapolis, Md.: Naval Institute Press, 1991.
- Mahan, A.T. *The Influence of Sea Power Upon History: 1660-1873*. Mineola: Dover Publishing, 1890.
- Merriam-Webster Inc. *Merriam-Webster's Collegiate Dictionary*. 11th ed. Springfield, Mass.: Merriam-Webster, Inc., 2003.
- Miller, Edward S. *War Plan Orange: The U.S. Strategy to Defeat Japan, 1897-1945*. Annapolis: The Naval Institute Press, 1991.
- Miller, Roger G. *To Save a City : The Berlin Airlift, 1948-1949*. College Station, TX: Texas A&M University Press, 2000.
- Millett, Allan Reed, and Peter Maslowski. *For the Common Defense : A Military History of the United States of America*. Rev. and expanded. ed. New York: Free Press, 1994.
- Milner, Marc. "The Battle That Had to Be Won." *Naval History* 22, no. 3 (2008).
<http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=31947739&site=ehost-live&scope=site>, (accessed 13 April 2012).
- Mitchell, William, and Robert S. Ehlers. *Winged Defense; the Development and Possibilities of Modern Air Power - Economic and Military*. 2009 ed. Tuscaloosa: The University of Alabama Press, Fire Ant Books, 1925.
- Mitchell, William, and Lyman L. Woodman. *The Opening of Alaska*. 2nd ed. Missoula, Mont.: Cook Inlet Historical Society, 1988.
- Moltke, Helmuth, and Daniel J. Hughes. *Moltke on the Art of War : Selected Writings*. Novato, CA: Presidio Press, 1993.
- Muller, Richard. *The German Air War in Russia*. Baltimore, Md.: Nautical & Aviation Pub. Co. of America, 1992.

- Murray, Williamson. *Strategy for Defeat: The Luftwaffe, 1933-1945*. Maxwell: Air University Press, 1983.
- Neiberg, Michael S. *Warfare in World History* Themes in World History. London ; New York: Routledge, 2001.
- O'Brien, Phillips Payson. *Technology and Naval Combat in the Twentieth Century and Beyond* Cass Series--Naval Policy and History. London ; Portland, OR: Frank Cass, 2001.
- Osinga, Frans P. B. *Science, Strategy and War : The Strategic Theory of John Boyd* Strategy and History. London ; New York: Routledge, 2007.
- Overy, Richard J. *The Air War: 1939-1945*. Washington, DC: Potomac Books, 2005.
- Peattie, Mark R. *Sunburst: The Rise of Japanese Naval Air Power, 1909-1941*. Annapolis: Naval Institute Press, 2001.
- Pratt, Edwin A. *The Rise of Rail-Power in War and Conquest, 1833-1914, with a Bibliography*. London,: P. S. King, 1915.
- Price, Alfred. *The Luftwaffe Data Book*. Pennsylvania: Stackpole Books, 1997.
- Ropp, Theodore. *War in the Modern World*. New, rev. ed. Baltimore, MD: John Hopkins University Press, 2000.
- Roskill, Stephen Wentworth. *The War at Sea, 1939-1945*. Vol. 2. 3 vols. History of the Second World War United Kingdom Military Series. London,: H.M. Stationery Off., 1954.
- Royal Institute of International Affairs. *Hitler's Europe*. Oxford, 1956.
- Sammartino, Annemarie. *The Impossible Border : Germany and the East, 1914-1922*. Ithaca, N.Y.: Cornell University Press, 2010.
- Schelling, Thomas C. *Arms and Influence*. New Haven, CT: Yale University Press, 2008.
- Sherry, Michael S. *The Rise of American Air Power: The Creation of Armageddon*. New Haven: Yale University Press, 1987.
- Smith, Merritt Roe, and Leo Marx. "Introduction." In *Does Technology Drive History? : The Dilemma of Technological Determinism*, edited by Merritt Roe Smith and Leo Marx, xv, 280 p. Cambridge, Mass.: MIT Press, 1994.
- Steinhoff, Johannes. *Messerschmitts over Sicily : Diary of a Luftwaffe Fighter Commander*. 1st ed. Stackpole Military History Series. Mechanicsburg, PA: Stackpole Books, 2004.
- Stone, Norman. *The Eastern Front, 1914-1917*. New York: Scribner, 1975.
- Taylor, Charles Fayette. *The Internal-Combustion Engine in Theory and Practice*. Vol. 2. 2 vols. 2nd ed. Cambridge, Mass.: M.I.T. Press, 1985.
- Terraine, John. *Business in Great Waters : The U-Boat Wars, 1916-1945*. London: L. Cooper, 1989.
- Thucydides, Robert B. Strassler, and Richard Crawley. *The Landmark Thucydides : A Comprehensive Guide to the Peloponnesian War*. New York: Free Press, 1996.

- Thurston, Robert Henry. *A History of the Growth of the Steam-Engine*. 1 ed. New York: D. Appleton and Company, 1878.
http://books.google.com/books/about/A_History_of_the_Growth_of_the_Steam_eng.html?id=VDgOAAAAYAAJ (accessed 1 May 2012).
- Tooze, Adam. *The Wages of Destruction: The Making and Breaking of the Nazi Economy*. New York: Penguin Group, 2006.
- Tung, Mao Tse. *The Selected Works of Mao Tse Tung*. Vol. II. Second Edition ed. Peking: People's Publishing House, 1965.
- Tunner, William H. *Over the Hump*. [1st ed. New York: Duell, Sloan and Pearce, 1964.
- Van Creveld, Martin. *Supplying War: Logistics from Wallenstein to Patton*. Cambridge ; New York: Cambridge University Press, 1977.
- _____. *Command in War*. Cambridge, Mass.: Harvard University Press, 1985.
- Wallin, Jeffrey D. *By Ships Alone : Churchill and the Dardanelles* Studies in Statesmanship of the Winston S Churchill Association. Durham, N.C.: Carolina Academic Press, 1981.
- Warren, John Cushman. *Airborne Operations in World War II, European Theater* Usaf Historical Studies,. Maxwell Air Force Base, Ala.: USAF Historical Division, Research Studies Institute, Air University, 1956.
- Weinberg, Gerhard L. *A World at Arms : A Global History of World War 2*. Cambridge Eng. ; New York: Cambridge University Press, 1994.
- White, Lynn Townsend. *Medieval Technology and Social Change*. Oxford,: Clarendon Press, 1962.
- Yergin, Daniel. *The Prize : The Epic Quest for Oil, Money, and Power*. New York: Simon & Schuster, 1991.

Government Documents

- United States Department of Transportation. *Freight Transportation: Global Highlights 2010*, Washington, DC: 2010.
- United States Navy "Mission of the United States Navy"
<http://www.navy.mil/navydata/organization/org-top.asp> (accessed 13 January 2012).
- United States Transportation Command. *2009 Annual Command Report*, Scott AFB, IL, 2010.
- The World Bank, *Gross Domestic Product*, 2010
<http://databank.worldbank.org/databank/download/GDP.pdf>
 (accessed 5 December 2010).
- _____, *World Bank Indicator Data*, <http://data.worldbank.org/indicator>
 (accessed 5 December 2011).